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Have we been measuring monetary policy correctly? Analysing the Federal Reserve's policies over the last century[1][2]

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Unlike the standard and erroneous practice of using the federal funds rate or another intermediate target to measure the monetary policy stance, a new procedure is developed using the actual Federal Reserve's instruments and the spread between short-term rates and the discount rate. Accordingly, I estimate a time-varying coefficient Bayesian SVAR for the interwar period and 1958-2007. The new technique unveils a new mechanism operating between Fed's policies and the real economy. The results show that monetary policy was mostly irrelevant for the interwar period, but the situation changed after 1958. For this last case, however, the new mechanism, which focuses on the cost at which banks obtain reserves, explains that positive spreads between the federal funds rate and the discount rate contributed to increasing inflation, revealing that the "price puzzle" is non-existent.

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- *Keywords: monetary policy, Federal Reserve, Bayesians, SVARs, price puzzle, federal funds rate*

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1. Introduction

The Great Recession and, inherently, the inability to avoid it supposed, or should have supposed, an inflection point. It showed that monetary policy, as a tool to achieve central banks' goals, was not managed correctly and therefore not properly understood. That lack of understanding means that our knowledge about the channels whereby monetary policy operates must be incorrect at some stage. To address that issue, this paper takes not only a step forward, but also to the side, uncoupling from the standard and widespread approach to measuring the impact of monetary policy on the real economy. The step forward is materialized in the review of the Federal Reserve's history from its early days to the years prior to the Great Recession, regarding how this institution and its members reacted to political and economic events, how those actions supposedly influenced the American economy's performance and how monetary policy evolved until the years prior to the Great Recession. Thus, while the literature has focused only on certain periods of interests, the purpose of this review is to draw common patterns from the long-term picture and learn how monetary policy instruments were used and interacted with inflation, output and the money supply. Once a better understanding of the Fed's instruments is acquired, the step to the side is inevitable and supposes the major contribution of this paper. The federal funds rate, another short-term money market rate or reserve measures have been used extensively as Fed's instruments in the literature to analyze the monetary policy stance and its impact on the real economy; however, by definition, they are intermediate targets. The actual instruments are open market operations (henceforth OMO), the discount rate and the reserve requirements ratio[4]. The conceptual mistake and the subsequent erroneous use of intermediate targets to measure the monetary policy stance introduce bias into the model (explained in section 2) and provide the wrong conclusions in relation to the impact of Fed's policies on the economy. Moreover, the correct use and understanding of the actual instruments, and the incentives they produce for the banking sector, inevitably lead to the creation of a new variable that measures arbitrage opportunities for bank reserves and provides an explanation for the known price puzzle, whereby when interest rate are raised, inflation increases. Therefore, the novelty of this paper is the analysis of longer periods with the use of the actual instruments and the new variable. The new set-up facilitates the study of and shed new light on the relationship between instruments and the real economy, and potential regime changes in Fed's policies. As a result of measuring monetary policy stance

[4] After the 2008 crisis, new instruments were incorporated. See https://www.federalreserve.gov/monetarypolicy/policytools.htm.

correctly, a new hypothetical mechanism whereby monetary policy operates is discovered. This mechanism focuses on the source from where banks obtain reserves, and how the different cost of each source has a different impact on the economy. It also provides an explanation for the price puzzle and claims that there is not puzzle, but bad policies applied by the Fed, when it allowed positive spreads between short-term rates and the discount rate.

While a vast literature exists covering how the Federal Reserve's monetary policy stance has influenced the American economy's performance, references to the instruments have been used only and occasionally for those analyzing the interwar period, although from a narrative perspective; whereas to the best of my knowledge, there is no reference to the instruments for the second half of the twentieth century, despite the use of advanced methodologies. For the interwar period, Miron (1988) focused on monetary aggregates, and referencing how the Fed used the discount rate, he claimed that Fed's policies might have created more volatility in inflation and output during the 1920s and part of the 1930s. Bordo (1993) analyzed and compared how different monetary regimes determined the evolution of real variables. By estimating a bivariate VAR on the price level and output, he stated, "the gold standard and interwar period emerge as a relatively unstable period stressed by widely dispersed supply shocks" (Bordo 1993, p. 16). For those attributing the responsibility for the Great Depression, the debate has focused on whether the death of Governor Strong produced a change in policy implementation, mostly when using OMO, although also commenting changes in the discount rate. For example, Friedman and Schwartz (1963), Bordo and Schwartz (1999) and Hetzel (1985) considered Strong's years as governor of the New York Fed as a period of mostly successful monetary policy, but, once he died, those who opposed his ideas took charge, which could have created or worsened the Great Depression. On the other hand, Wicker (1965), Brunner and Meltzer (1968) and Wheelock (1989, 1990) argued that, had Strong lived during those years, the outcome would have been the same, as the policies were already ineptly administrated during his lifetime. By looking at the evolution of some real variables, market rates, the discount rate and OMO, Hamilton (1987) concluded that despite the slight change in policies during the 1920s, it was insufficient to explain the Great Depression and that some other factors were involved. Along this line and as exception in methodology, Ritschl and Woitek (2000) estimated a BVAR, using non-borrowed reserves, the discount rate or the short-term money market rates to measure the impact of monetary policy on real variables. They found that positive shocks to the discount rate and intermediate targets had, in general, a positive impact on inflation (price puzzle) and negative on output. They concluded that the monetary policy before the stock market crash did not cause the recession.

At most, it could have produced a mild recession, which is also in line with Temin (1973). For the period after 1933, Friedman and Schwartz (1963) and Orphanides (2004) claimed that, despite the Fed's inactivity during those years, the inflow of gold was the factor guiding the well functioning of the economy.

For the second part of the twentieth century, since the Fed recovered its independence from the Treasury in 1951, the literature has been approaching Fed's monetary policy stance rather methodologically and mainly immersed in the "good luck, good policy" debate[5], which is also related to monetary policy switching regimes. At the same time, this literature gathers common characteristics, such as the use of VARs and the controversy about the price puzzle. As commented previously, the use of the federal funds rate as Fed's instrument has been the common procedure to evaluate monetary policy actions and I will specify when some variations are applied. On the one hand, some authors have focused on Fed's responses to movements in output and inflation. Such is the case of Clarida, Gali and Gertler (2000) using a GMM for a monetary policy reaction function. They observed that a policy change occurred during the Volcker–Greenspan era. This change is assumed to have brought stability to the economy, avoiding the indeterminacy equilibria existing before the Volcker era, by responding more aggressively to inflation. With a similar model, Favero and Rovelli (2003) obtained analogous results. Cogley and Sargent (2005), applying a similar model to the one in Canova and Gambetti (2009) indicated below, but using the 3-month Treasury bills rate, observed changes in the Federal Reserve's stance toward inflation, but their conclusion was not decisive in disentangling the good luck from the good policy hypothesis. Orphanides (2004b), comparing Taylor rules with real data and the data available for the Fed, claimed that bad policies played a relevant role during the Great Inflation, as the Fed wrongly understood how the economy worked, mistakenly predicting larger output gaps and intervening in the economy more than necessary, thus creating instability. Once it focused on inflation rather than the output gap, and the interventions became fewer and more accurate, the situation improved.

On the other hand, the object of study is rather the effect of positive shocks to the federal funds rate or a similar variable, on the real economy and money aggregates. Firstly, however, the use of VARs is evaluated. Giannone, Lenza and Reichlin (2008) examined VAR models of different sizes and trusted more those that included more variables, arguing that the

[5] This debate evaluates whether the American economy's performance has been the result of Fed's policies or external shocks. The main focus is on the pre- and post-Volcker era.

VARs supporting the good luck hypothesis, which contain fewer variables, are naïve models; Benati and Surico (2009), who, using a New Keynesian model via Bayesian methods, whereby they moved from determinacy to indeterminacy states, were able to demonstrate that those works based on VARs and supporting the good luck hypothesis may have misinterpreted good policy as good luck. In this case, inflation responded negatively to a positive nominal interest shock. Beyond VARs evaluation, Boivin and Giannone (2006), who used an SVAR, founded that a positive shock to the federal funds rate originated a price puzzle when analyzing the inflation responses, whereas output responded negatively. With a VAR, Christiano, Eichenbaum and Evans (1998) found that the Federal Reserve's activism declined in the late 1960s and was neutral in the early 1970s. Then, the Fed became passive for the remainder of the 1970s, not increasing the federal funds rate enough to counteract inflation. In 1981, monetary policy became activist again until Greenspan's term, when it decreased slightly but regained strength since 1993. By using alternatively the federal funds rate or nonborrowed reserves, a positive shock to these variables showed mostly a negative impact on the money supply and output, and initially no effect on inflation, which turned negative after roughly a year. However, when commodity prices were excluded from the estimation, a price puzzle was found. Primicery (2005), using a time-varying coefficient Bayesian structural vector autoregression (TVC-BSVAR), argued that, despite observing a change in monetary policy, it was not significantly different between the pre- and post-Volcker periods, and Canova and Gambetti (2009), with a similar method, found that the policy was the same for both periods, showing that the Taylor principle was not satisfied in any of the periods and that the transmission of monetary policy shocks to output and inflation remained stable over the periods analyzed, but inflation's persistence changed over time. For the former, a small price puzzle is found depending on the period, which disappears quickly, while for the latter, both, inflation and output respond negatively to a positive federal funds rate shock. Using a semi-structural VAR, including the federal funds rate, nonborrowed and total reserves, Hanson (2006) showed that a change in the policy is noticeable after Volcker's era but that it seems more probable that shocks coming from variables such as output or prices were important in determining the economic performance. Again, a price puzzle was found.

For those analyzing the evolution and volatility of inflation and output, but still using the same variables to measure monetary policy actions, Gali and Gambetti (2009), using a TVC-BSVAR and analyzing the variations in non-technology and technology shocks, concluded that monetary policy could have been among the factors explaining the decrease in volatility in output after the Great Inflation. Stock and Watson (2003), examined time-varying

standard deviations and VARs with break tests and attributed the reduction of volatility to the decrease in shocks but also ascribed 10%–25% of the importance to improved monetary policy. Moreno (2004) developed a rational expectations model and showed that CPI inflation volatility declined in the 1980s and 1990s because of the propagation mechanism, but, considering the GDPD volatility, the decline is explained by smaller shocks. Federal funds rate and 3-month Treasury bill rate were used as Fed's instruments.

This paper uses the same model as Primiceri (2005), namely a TVC-BSVAR with Del Negro and Primiceri's (2013) corrigendum, but including the actual Fed's instrument along with a variable measuring the difference between the short-term rate of reference for the period under analysis and the discount rate. The results suggest that monetary policy was almost irrelevant for the interwar period, as none of the instruments or the new variable is significant when analyzing its impact on output and inflation. For the second period, monetary policy gains relevance and the discount rate and the spread are able to influence the evolution of the variables under analysis. Furthermore, two regimes changes are observed around 1965 and 1990. While the first one may correspond to a change in Fed's policies, the second one is probably due to a change in the banking sector's behavior. Last and most important, the use of the spread unveils a new mechanism that explains the prize puzzle found in papers such as Barth and Ramey (2001), Boivin and Giannoni (2003), Bernanke, Boivin and Eliasz (2005), Uhlig (2005) and Hanson (2006), among many others. The reason for the creation of this variable is that for those periods when this spread was positive, banks had the possibility of obtaining higher profits by borrowing more cheaply at the discount window and lending at higher rates. The obtaining of cheaper reserves increased the possibility that banks set relatively lower loans rates in relation to the raises in the federal funds rate. Consequently, the insufficient restrain of credit and the money supply, triggered higher inflation levels. Therefore, I claim that there is no puzzle in prices behavior but bad Fed's policies by allowing those positive spreads.

The paper is structured as follows. Section 2 develops the theoretical framework necessary to understand the model, which is described in Section 3. Section 4 covers the data sources, the identification structure of the VAR and the priors used for the model. Section 5 analyzes the results obtained. Section 6 gathers all the lessons and patterns obtained from section 5. Finally, section 7 summarizes the main conclusions.

2. Theoretical framework

As commented previously, the common way of approaching and evaluating the monetary policy stance, in methodological terms, has been the use of the federal funds rate or some measure of reserves (typically total reserves or nonborrowed reserves) as Federal Reserve's instruments. By definition, this assumption is erroneous. The federal funds rate or any type of reserve measure has always been and will be an intermediate target to achieve a final target such as price stability, stable growth or low unemployment. Actually, the Federal Reserve has available three instruments to achieve its intermediate and final targets. Such instruments are OMO, the discount rate and the reserve requirements ratio. Accordingly, to analyze the Federal Reserve's role and the impact of its policies on the American economy's performance, it is appropriate to use those instruments. In my model, I count with two of them, the discount rate and OMO, two intermediate targets, the spread between the short-term rate of reference (call loans rate[6] or federal funds rate) and the discount rate,[7] what is the new variable commented above, and M1, and two final targets, the industrial production index (IPI) and CPI inflation. The reserve requirements ratio is not incorporated given that it hardly varies over time.

To understand why it is erroneous to use of the federal funds rate (or another short-term rate)[8] to measure monetary policy, the money market must be conceptualized as two submarkets. The first submarket includes the central bank, in this case the Fed on the supply side, and the banking sector on the demand side. In the second submarket, the banking sector switches to the supply side, the other agents of the economy being the demand side. The Fed controls the federal funds rate by purchasing and selling securities in the open market and

[6] The call loans rate, for the interwar period, was the most similar rate to the present federal funds rate. "The market for brokers' loans, as it is generally conceived, is centered around the New York Stock Exchange. Although some of these loans grow out of a customer relationship between banks as lenders and brokers and dealers as borrowers, the majority are made in the open market on a strictly impersonal basis. The market in which these loans are made was until recent years the most active and the most sensitive of the money markets of the country. It was the market where surplus funds of banks, and sometimes of other lenders, could generally be readily placed or from which funds could be quickly withdrawn when needed. Because of the dominance of call loans, the branch of the money market dealing in brokers' loans has been designated as the call money market" (Board of Governors of the Federal Reserve System (U.S.), 1935–. *Banking and Monetary Statistics, 1914-1941*, 1943, https://fraser.stlouisfed.org/title/38, p. 434).

[7] In this case, it is not really an intermediate target but a hybrid between an intermediate target and an instrument, because the short-term rate is an intermediate target and the discount rate an instrument.

[8] The same applies to any measure of reserves, as a reserve target will determine the federal funds rate or the other way around.

increasing or decreasing the discount rate. Thus, the Fed controls the amount (with OMO) and price (with the discount rate and federal funds rate) of money in the first submarket, subject to the banking sector's demand for money and subsequent decisions about the federal funds rate and to considerations regarding whether that level of demand could harm the stability of the economy. Given the price and amount of money set by the Fed, banks will also decide, the amount (loans), although just in part, and price (loans rate) of money in the second submarket. Unlike Fed's intentions, banks will set prices and amounts conditioned on their profitability. Their decisions about prices and quantities will depend, mainly, on the cost of money to them, namely, reserves cost, and the prospect of profits from lending.

Thus, the federal funds rate is affected by supply and demand forces in the first submarket. The banking sector (as the demand side) will set a federal funds rate depending on several factors, such as the demand for reserves necessary to back the amount of loans, banks' surplus reserves, expectations about the adequate level of reserves to hold for the future or their own desire regarding the optimum level of reserves held under certain circumstances. Meanwhile, the Federal Reserve (supply side) will target a federal funds rate to control the evolution of the demand side by using OMO and the discount rate. However, the simultaneous use of both instruments to set the same level of the federal funds rate at two different points in time will be different. The reason is that as the federal funds rate depends also on the banking sector, the Fed will have to purchase or sell different amounts of securities and the discount rate will have to be set at different levels, to provide banks with the required amount of reserves determined by the demand forces, under the federal funds rate targeted. In the end, the same level of the federal funds rate can produce different equilibria. A greater demand for money faced with a greater supply of money can have a price of equilibrium (the federal funds rate in this case), which can be the same with a lower demand and supply of money. Nonetheless, this lower or greater supply of money will have different effects on the economy, because under the same federal funds rate, the cost and amount of reserves provided will have different impacts on the loans rate, which in the end, is the rate determining a greater or lower demand for loans. Hence, including the federal funds rate in the econometric model to represent the monetary policy stance is erroneous, because, by capturing demand and supply forces, the supposed policies carried out by the Fed will produce misleading results, as the banking sector can, to some extent, modify them and the results will capture those demand side modifications. By using the real instruments, Fed's policies, namely the supply forces, are isolated from the demand forces. However, despite being isolated from the Fed's instruments, the federal funds rate entails another problem if included in the model alone. Its impact on the second submarket

is relative, as it depends on the discount rate levels. As both rates measure the cost of reserves from two different sources, banks will opt for the cheaper cost once arbitrage opportunities appear. This is where the new variable (the spread between the short-term rate of reference and the discount rate) plays its role.

Sometimes, even though the Fed increased the federal funds rate, if the spread between the federal funds rate (or another short-term rate) and the discount rate was positive, it offered profitable opportunities for banks. Thus, they continued borrowing cheaper reserves at the discount window and lending at higher rates than the discount rate. Lending increased or at least did not diminish as much as the Fed intended, because with a cheaper source for reserves, the federal funds rate was likely to not have a one to one impact on the loans rate, since the most important factor determining the loans rate is the cost of money to banks. As the impact ratio would be below one, the loans rate could not exert enough restrain on the demand for credit. Accordingly, the Fed partially lost the control of its targets.

Thus, in the model presented here, while Fed's instruments capture the supply side of the money market, this new variable will be a representation of those periods when banks could obtain cheaper reserves and therefore, the loans rate could not be moving one to one with the federal funds rate. Accordingly, positive spreads are likely to exert inflationary pressures, while negative spreads will do the opposite once the interest rate is raised, as long as that interest rate is high enough to restrain the demand forces.

2.1 Discarding some concerns

Given the novel exposure of this mechanism, it is necessary to clarify that this new procedure can be applied regardless of the period, the monetary regime or the financial environment.

Regarding the monetary regime, the advantage of using real instruments is that the analysis of the policies undertaken by the Fed will not be altered by the different active monetary regimes during the period of study, because a monetary regime implies an intermediate target, such as gold, the money supply, interest rate, reserves, exchange rate and so on. Consequently, if an intermediate target is used as a measure of the monetary policy stance, apart from the problem explained above about the federal funds rate (which also applies to the other intermediate targets), that variable must be removed from the model (a VAR in this case) or ordered differently as the monetary regime changes. Conversely, using Fed's instruments, regardless of the monetary regime, the same instruments have to be used to achieve both intermediate and final targets. The only way whereby the Fed can achieve its goals under any monetary regime goes through the use of the discount rate and OMO.

Concerns may be raised as well about how the financial environment has evolved and how it could have modified the relationship between the Federal Reserve and the banking sector. The most important source of change could be Regulation Q, as it imposed interest rate ceilings on deposits rates. This regulation was active from 1933 to 1986 but was binding only when market rates reached ceiling levels around the 1960s. That meant that banks could not offer enough yields to attract depositors. Consequently, saving and loans associations would catch those clients. According to Koch (2015), interest rate ceilings contracted banks' credit growth and affected the lending channel, because without more deposits, banks could not increase lending. This extra tool included in the Fed's armory would be, therefore, a significant omitted variable once ceiling rates were below market rates. There is, however, a significant flaw in the premise that banks need deposits to lend, as banks use those deposits as reserves. The reality is quite different. Banks first lend, and just after, look for the necessary reserves to back the demand for loans. There is an extensive literature explaining this issue, such as Moore (1988), Bindseil (2004) or Jakab and Kumhof (2015) among many others. This fact is also supported by some data. In Koch (2015, Figure 1), he displayed when and for how much markets rates were above ceiling rates. The periods of higher rates, except for 1960, coincides with those periods when the spread between the federal funds rate and the discount rate was positive (Figure 1). If those periods are now contrasted with Figure 2, where the amount of borrowed reserves is displayed, the evidence is clear, as borrowing increased when the spread was positive. Thus, even if banks had not been borrowing for the opportunity of obtaining cheaper reserves at the discount window, which is the case, the lower amount of reserves from deposits could have been counteracted with borrowing and credit would have not been restrained. Also, it is not surprising Koch's conclusion that when the interest rate ceiling was binding, credit decreased. As expected, for periods of increased market rates, at some point, lending levels will decrease. On top of that, there are also references in Meltzer (2009a, p.470, 608 and 648) to how banks evaded regulation by offering different kinds of deposits or services. However, the reader may be confused when reading that banks complained about ceiling rates (Meltzer 2009a, p.383). If they did not need deposits to lend, why did they complain? When market rates were above those ceilings, banks could obtain cheaper reserves from deposits, but the larger the spread, the fewer quantity of deposits was demanded. Therefore, even if ceiling rates were raised and banks

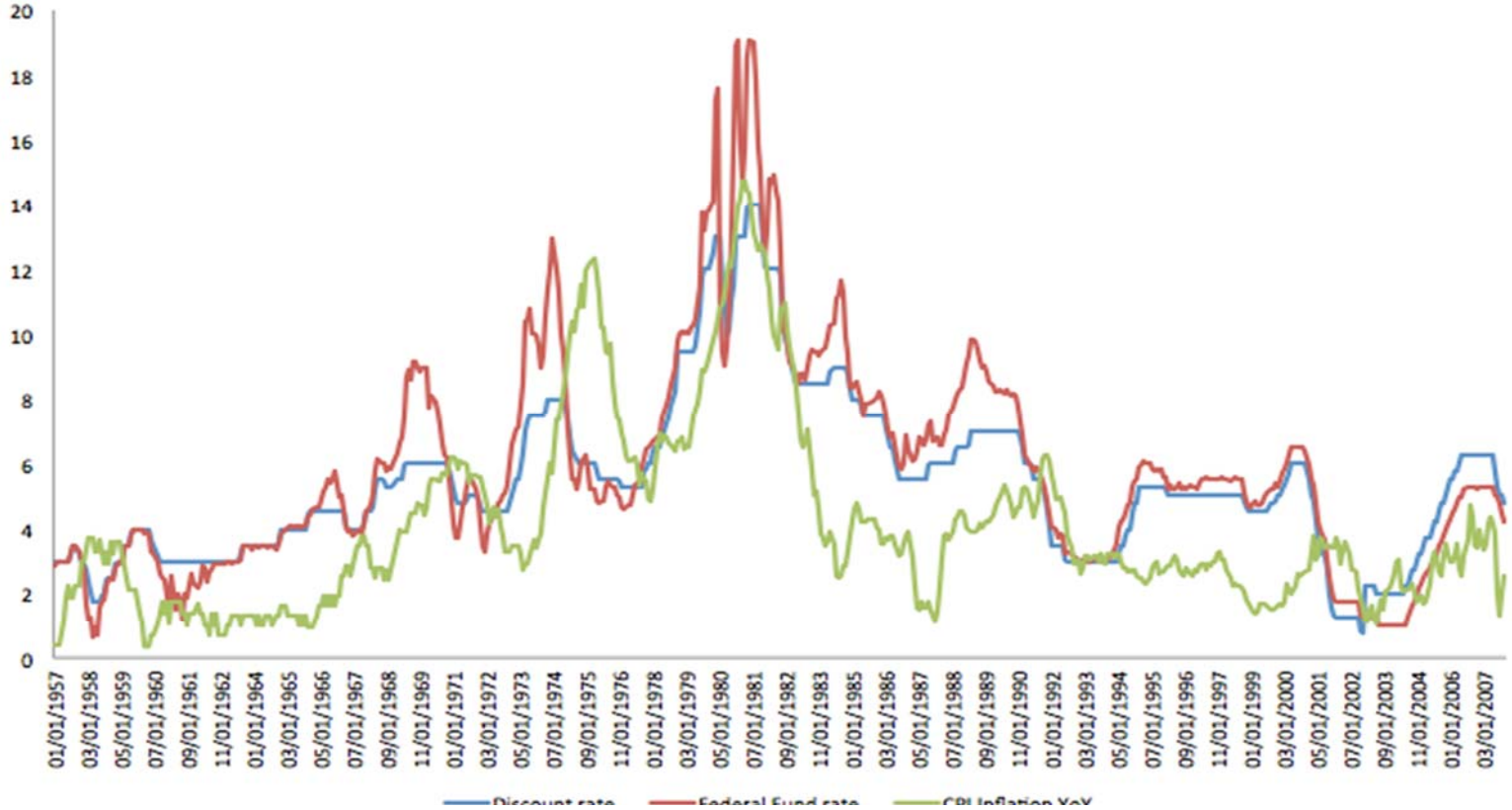


Figure 1 – Data source: FRED

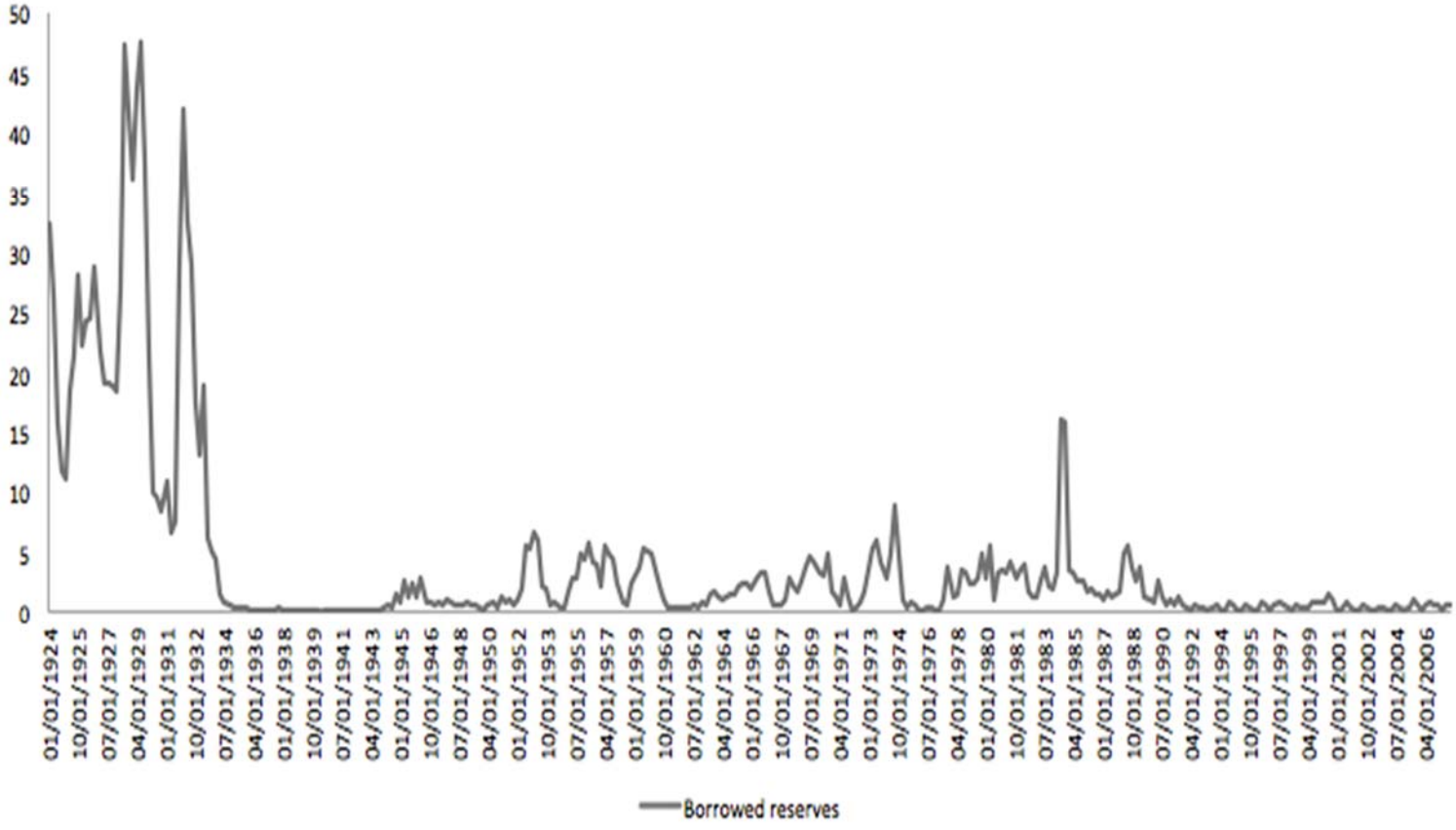


Figure 2 – Data source: FRED and FRASER

had to pay more to their clients, they could still obtain cheaper reserves than from the discount window or the federal funds market.

Other source of concern is the evolution of the discount window. There are some misconceptions regarding its use and even though the model used in this paper will capture any related variation or regime change, a couple of things need to be clarified. First, in 1955, the Board issued regulation A, where System orthodoxy was that banks did not borrow for profit but only reluctantly for need. Later, the discount rate stopped being a ceiling on the federal funds rate. It triggered more borrowing as seen in Figure 2, but the System needed a long time until it changed its mind and accepted that banks also borrowed for profits. Therefore, the supposed stigma for borrowing for that period is false. Second, the Depository Institution Deregulation and Monetary Act of 1980 allowed more institutions access to the discount window. Despite this fact, the analysis undertaken here is in aggregate level. That is, before some institutions could have access to the discount window, they were likely to borrow from the banking sector, which in turn, would borrow at the discount window if more reserves were necessary. Hence, no significant regime change is expected under such deregulation act.

3. Methodology

The model used in this paper is the same as that in Primicery (2005), a TVC-BSVAR, in which, unlike other similar models, not only the coefficients vary but also the variance covariance matrix. The code used to estimate the model was downloaded from Gary Koop's website.[9] The advantage of this model is that the drifting coefficients are able to capture nonlinearities or time variation in the lag structure of the model, while the multivariate stochastic volatility is able to capture possible heteroscedasticity of the shocks and nonlinearities in the simultaneous relations among the variables of the model. Thereby, it allows the data to determine whether the possible variations observed in the relation among variables emanates from the shocks (impulse) or changes in the propagation mechanism (response). The adequacy of this model for the purpose of the paper is founded on its capacity to capture continuous and smoothed switching regimes, unlike those works that modeled time variation with discrete breaks. For the topic addressed in this case, it is expected that the Federal Reserve, banking sector and other agents of the economy learn from the evolution of the economy and each other. The

[9] https://sites.google.com/site/garykoop/home/computer-code-2.
The only modifications applied to the code are made to adapt it to the data used here as well as for those tools necessary for the representation of the results. The process of estimation is entirely as found in the file.

learning process is considered to be slow and not to happen overnight. Hence, changes in the behavior of those agents, as a consequence of their learning process, will evolve smoothly.

Using the same notation as Primiceri, the model is the following:

$$y_t = c_t + B_{1,t}y_{t-1} + \ldots + B_{k,t}y_{t-k} + u_t \quad t = 1, \ldots, T \qquad (1)$$

where y_t and c_t are $n \times 1$ vectors of observed endogenous variables and a vector of time-varying coefficients multiplying constant terms, respectively. $B_{i,t}$, $i = 1, \ldots, k$, represents $n \times n$ matrices of time-varying coefficients. Last, u_t are heteroscedastic unobservable shocks. The variance covariance matrix Ω_t is triangularly reduced and defined by

$$A_t \, \Omega_t A'_t = \sum_t \sum'_t \qquad (2)$$

where A_t is a lower triangular matrix with ones in the main diagonal, $\alpha_{ij,t}$ being the non-zero and non-one elements of the matrix. $\sum_t$ is a diagonal matrix with $\sigma_{n,t}$ elements in the diagonal. Hence,

$$y_t = B_{0,t} + B_{1,t}y_{t-1} + \ldots + B_{k,t}y_{t-k} + A_t^{-1}\sum_t \varepsilon_t \qquad (3)$$
$$V(\varepsilon_t) = I_n$$

Stacking all the $B_{k,t}$s in a vector,

$$B_t = vec(B'_t) = [B_{0,t}, B_{1,t}, B_{2,t}, \ldots B_{k,t}]'$$

and with

$$X_t = I_n \otimes [1, y_{t-1}, y_{t-2}, \ldots y_{t-k}]',$$

the VAR can be represented and modeled as:

$$y_t = X'_t B_t + A_t^{-1}\sum_t \varepsilon_t \qquad (4)$$

Stacking by rows the elements $\alpha_{ij,t}$ of the matrix A_t and the elements $\sigma_{n,t}$ of the matrix $\sum_t$, the state vectors or transition equations representing the dynamics of the model are:

$$B_t = B_{t-1} + v_t \qquad (5)$$

$$\alpha_t = \alpha_{t-1} + \zeta_t \qquad (6)$$

$$log\ \sigma_t = log\ \sigma_{t-1} + \eta_t \qquad (7)$$

where both the B_ts and the non-zero and non-one elements of the matrix A_t, α_t, follow random walks, while the standard deviations of equation (7) follow a geometric random walk, accordingly belonging to the stochastic volatility models. The innovations of the model are assumed to be jointly normally distributed, supposing the following variance covariance matrix:

$$V = Var\left(\begin{bmatrix} \varepsilon t \\ vt \\ \zeta t \\ \eta t \end{bmatrix}\right) = \begin{bmatrix} In & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{bmatrix} \qquad (8)$$

where I_n is an n-dimensional identity matrix and Q, S and W are positive definite matrices. As Primiceri pointed out, the zero blocks could be replaced by non-zero blocks, but there are two reasons for the assumptions taken. First, as Primiceri (2005) already considered the number of parameters to be high and adding non-zero blocks would require a sensible prior to prevent ill-determined parameters, I include the double of the variables in the model. Second, I do not have any structural interpretation to impose on the different sources of uncertainty. S is assumed to be block diagonal, with blocks corresponding to parameters belonging to a separate equation; that is, the coefficients of the contemporaneous relations evolve independently in each equation. For the estimation of the model, I refer the reader to Appendix A of Primiceri (2005), taking into account Del Negro and Primiceri's (2013) corrigendum, whereby the algorithm used for the Gibbs sampling undergoes a modification regarding the blocks from which the draws are taken.

In this model the Bs are restricted to being non-explosive to impose stability. As Koop and Potter (2011) (K-P henceforth) explained, "in the absence of such inequality restrictions (or a very tight prior), Bayesian TVP-VARs will place a large amount of a priori weight on nonsensical paths for the states." Primiceri used Carter and Kohn's (1994) algorithm, which draws an entire vector of states and rejects any that violate the constraint imposed. The problem of applying this algorithm is that, when the number of parameters is relatively high, it is easy for the algorithm to become stuck drawing explosive Bs. Thus, all the draws are discarded and computation is not feasible, as is the case in this paper for some cases. To solve this problem,

K-P developed a single-move algorithm.[10] While the MCMC algorithm in Primiceri (2005) draws from state space models without the inequality restriction, K-P's single-move algorithm draws from the state space model subject to the inequality restriction, drawing the states one at a time. This single-move algorithm does not become stuck rejecting every candidate draw, like the multi-move algorithm. It draws B_t from $p(B_t|y^T, Q, B_{t-1})$,[11] accepting the single draw B_t with a certain acceptance probability if it has satisfied the restriction imposed. Now, although the probability of becoming stuck diminishes significantly, the algorithm mixes more slowly.

4. Data, identification strategy and priors

The sample under analysis is split into two periods. The first one covers the interwar period with monthly data from 1925:I to 1939:XII, and the second period encompasses the interval between 1958:I and 2007:IV with quarterly data. The reason for using different periodicity is that for the interwar period the sample size is excessively small if using quarterly data, taking into account that a longer sample is necessary for the priors. For the first period, the variables used are the Industrial Production Index (IPI), the Consumer Price Index (CPI), M1, the difference between the stock exchange call loans rate and the discount rate (C-D), open market operations (OMO)[12] and the discount rate [13]. The first three variables and OMO are growth rates, while the spread and the discount rate are in levels. For the second period, the variables are the same except for C-D, as the stock exchange call loans rate is substituted for the federal funds rate (F-D). While the call loans rate and the federal funds rate represent different (although similar) money markets, they perform the same role. In both cases, they represent the price at which bank could obtain reserves, when they were not borrowed at the discount window. Another difference is that for the interwar period, the Fed did not target short-term rates directly as in the second period, when OMO were used for that purpose. However, those short-term rates were involuntarily conditioned by the movements in the discount rate anyways. That is, the short-term rate responded to demand forces for the interwar period rather than to Fed's desires as in the second period, but still, it was influenced by Fed's instruments. To have all the variables on the same scale, they are standardized $(y_t - E(y_t^*))/std(y_t^*)$. The order of the variables (contrary to that indicated above) takes the IPI as the last variable in the VAR

[10] Koop and Potter (2011). Section 2.3, pp. 13–15.

[11] The other blocks are not included in the notation (although they are in the algorithm), as the modification only affects the draws of B_t and Q.

[12] U.S. Government securities (bought outright and repurchases) and acceptances held by the Federal Reserve.

[13] Until 1948, the discount rate belongs to the New York Federal Reserve Bank as representative of all other Reserve Banks. Later, all of them offered a homogeneous rate.

and the discount rate as the first one. In this way, the relation among the variables has a structural interpretation: while the IPI reacts only after one lag to all the other variables' movements, the discount rate reacts contemporaneously to all of them. The order assumed is based on the mechanism described in section 2. The first price that the Fed sets in the first submarket is the discount rate. From there, it controls the federal funds rate or whatever intermediate target it has through OMO. Even though sometimes OMO and the discount rate will move at the same time, the discount rate remain at the same levels for longer periods. During those periods, the intermediate target is adjusted through OMO. Both instruments, voluntarily or not, will determine the spread. The data were collected from the National Bureau of Economic Research (NBER), the Federal Reserve Economic Data (FRED), the Bureau of Labor Statistics and the Reserve Archival System for Economic Research (FRASER).

Regarding the lag structure, I find limitations to this model. Given the high dimensionality of the parameters estimated, adding more than one lag in any of the periods triggers the draws from the B's distribution to be non-stationary. Having previously imposed the stationarity restriction, the multi-move algorithm used by Primiceri becomes stuck in the zone of the distribution where the draws are non-stationary; therefore, no draw is taken. Using K-P's single-move algorithm, I am able to introduce one lag more (including more than two lags makes the algorithm collapse). Thus, for the interwar period with monthly data, I use K-P's algorithm directly to have at least two lags, which are already few. For the second period, I present the results for one lag (multi-move algorithm) and comment the few relevant variations obtained with two lags (K-P's single-move algorithm).

4.1 Priors and computational details

For the first period, an invariant VAR from 1920:I to 1924:XII (60 observations) is estimated to calibrate the priors' distributions, while, for the second period, the priors are obtained from the period from 1948:I to 1957:IV (39 observations)[14]. The set-up for the priors (as written in Gary Koop's code) is the following:

$$B_0 \sim N(\hat{B}_{OLS}, 4 \cdot V(\hat{B}_{OLS})),$$
$$A_0 \sim N(\hat{A}_{OLS}, 4 \cdot V(\hat{A}_{OLS})),$$
$$\log \sigma_0 \sim N(\log \hat{\sigma}_{OLS}, 4 \cdot I_n),$$

[14] For the federal funds rate series, data is only available from 1954. As a proxy, I have used the 3-months T-bill rate from 1948 to 1954 to estimate the priors.

$$Q \sim IW(k^2_Q \cdot 60(\text{or } 39) \cdot V(\hat{B}_{OLS}), 60(\text{or } 39)),$$
$$W \sim IW(k^2_w \cdot (1+\dim(W)) \cdot I_n, 1+\dim(W)),$$
$$S_1 \sim IW(k^2_s \cdot (1+\dim(S_1)) \cdot V(\hat{A}_{1,OLS}), 1+\dim(S_1)),$$
$$S_2 \sim IW(k^2_s \cdot (1+\dim(S_2)) \cdot V(\hat{A}_{2,OLS}), 1+\dim(S_2)),$$

where S_1 and S_2 are the two blocks of S, $A_{1,OLS}$ and $A_{2,OLS}$ are the corresponding blocks of A_{OLS} and $k_Q = 0.01$, $k_S = 0.1$ and $k_W = 1$. Thus, the priors are not flat but diffuse.

For the first and second periods, when the single-move algorithm is used, 400,000 draws are generated, discarding the first 200,000 and using 1 in every 100 to avoid correlation between them. For the second period and the multi-move algorithm, 450,000 draws are generated, discarding the first 200,000 and using 1 in every 125. The difference in the number of draws is explained by the computational time necessary and the percentage of acceptance of draws for each algorithm. Regarding the computational time to estimate the model, the multi-move algorithm required around 60 hours, and the single-move algorithm about 23 days. Convergence tests are displayed in Appendix C.

5. Results

Even though the results presented in this section are linked to some of the most relevant facts within the Federal Reserve, or political and economic events, the reader can examine and link those results in greater detail to the narrative of the Fed's history available in Appendix D.

The TVC-BSVAR provides two different tools to evaluate the impact of the instruments. First, the impulse response functions will show the posterior mean of the response of certain variables to another variable shock. The use of time-varying coefficients allows the discovery of whether the interaction between two variables has undergone any significant change over the period under analysis. This may be the first hint regarding whether the Fed, at some point, modified its policies or used its instruments differently. Second, the posterior mean of the standard deviation of the residuals for each equation of the VAR will shed light on possible external shocks affecting the results, namely variables that are not included in the model, which could distort the relations observed between the instruments and the variables under analysis.

Before analyzing the results, I advise the reader to pay keen attention to the relations described in Figure 3 for the interwar period and Figure 1 for the second period between the discount rate, the short-term rate of reference and the levels of inflation, because they are

important to understand what the impulse responses display. It needs to be clarified that the analysis undertaken intends to comprehend the impact of the instruments on inflation, output and the money supply, regardless of the reasons behind Fed's decisions to use the instruments. That is, once the Fed increases the interest rate, because of correct or incorrect forecasts, anticipation to political events, international factors or whatever reason, that increase has an impact, and that impact is the only thing of interest in this study. This is the only way whereby a better understanding of the interaction between instruments and real variables or money aggregates can be acquired.

Given the detailed analysis of the impulse response functions and the number of figures in three dimensions, in this section, I only analyze the response of the final targets to the instruments and the new variable. The evaluation of the rest of the figures is available in Appendix A. Ordinary impulse response functions to analyze the responses' significance is evaluated only for the relationships between instruments and final or intermediate targets, and for selected years.

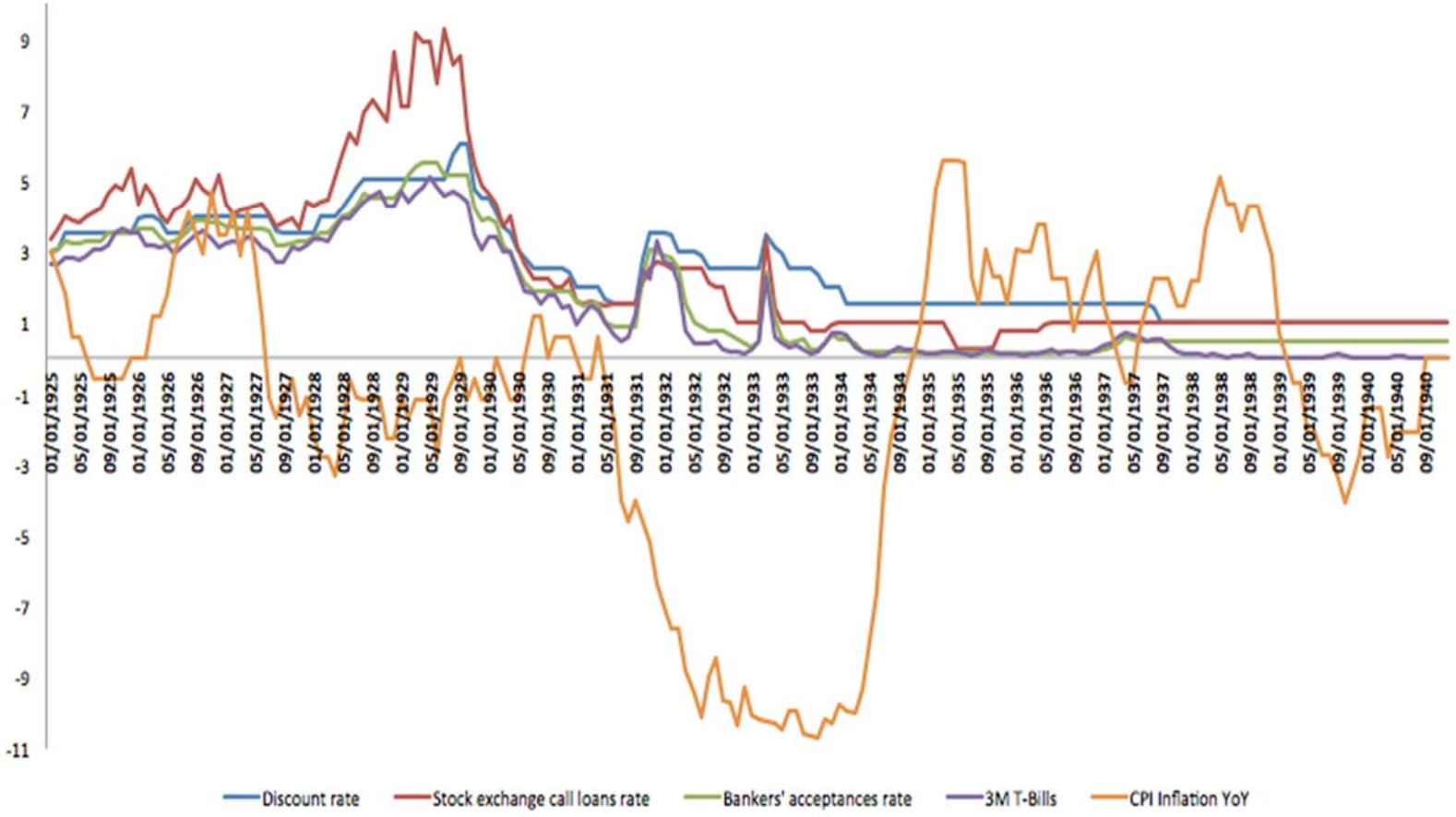


Figure 3 - Source: Banking and Monetary Statistics, 1914-1941 (FRASER) and Bureau of Labor Statistics

5.1 Interwar period (1925:I–1939:XII)[15]

The figures analyzed below display each period of the sample on the X-axis, the response to the shock from one to twenty months/quarters on the Y-axis and the scale of the response on the Z-axis.

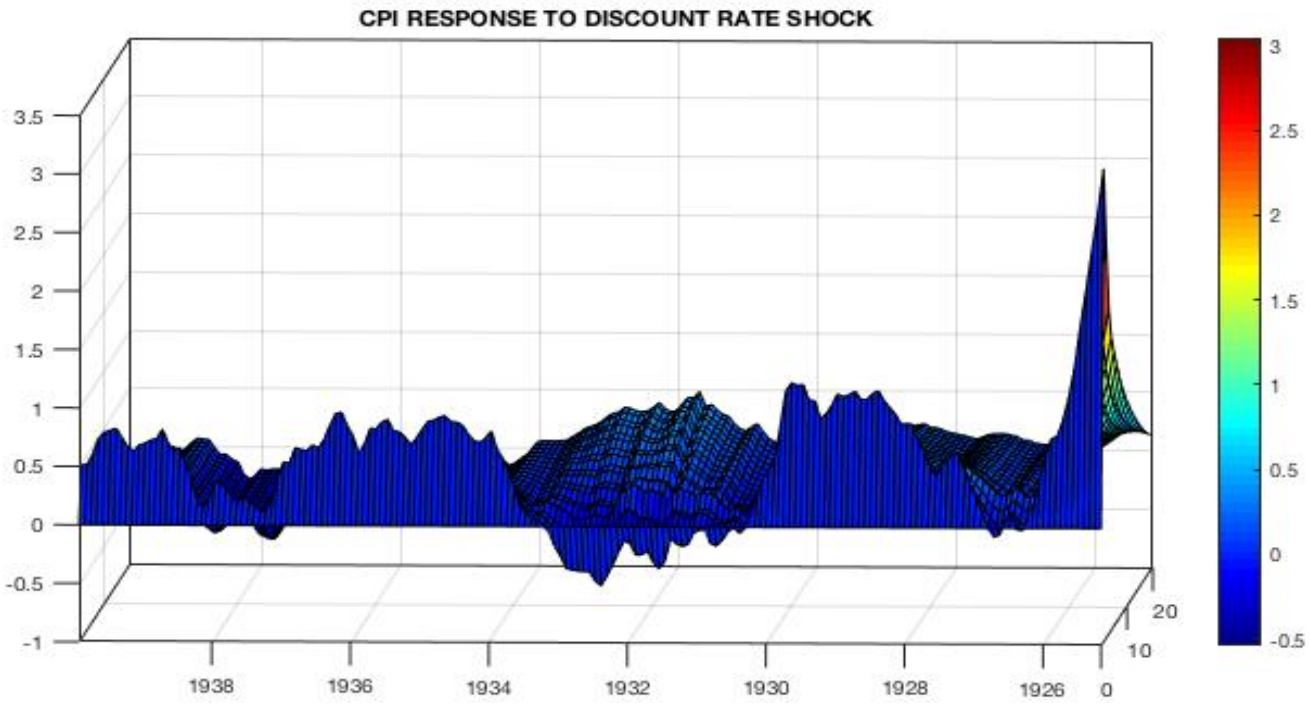


Figure 4.1 - CPI inflation impulse response to a discount rate shock. Note: Posterior means.

Looking at the discount rate shock (Figure 4.1), the inflation response is positive from 1925 to the end of 1929, with the exception of the almost-zero response around mid-1926. The positive response coincides with the discount rate being below or near the call loans rate (Figure 3). Those positive responses could be also capturing the inflows of gold once the discount rate was raised, triggering increases in the money supply and inflation, as long as those inflows were not offset. For 1926, the zero response corresponds to the fact that the discount rate was near the call loans rate. Between 1930 and 1934, the negative or zero response coincides with the facts that the discount rate in real terms was higher than represented because of the deflation. Also, it was above the call loans rate. After six months, the response becomes slightly positive. From 1934 to 1939, the response is positive but

[15] The results shown for this first period belong to the model with monthly data and two lags using K-P's algorithm. Even though the analysis starts in 1925, Appendix D presents the knowledge of the Fed since 1919, which is relevant to a better understanding of the policies undertaken later.

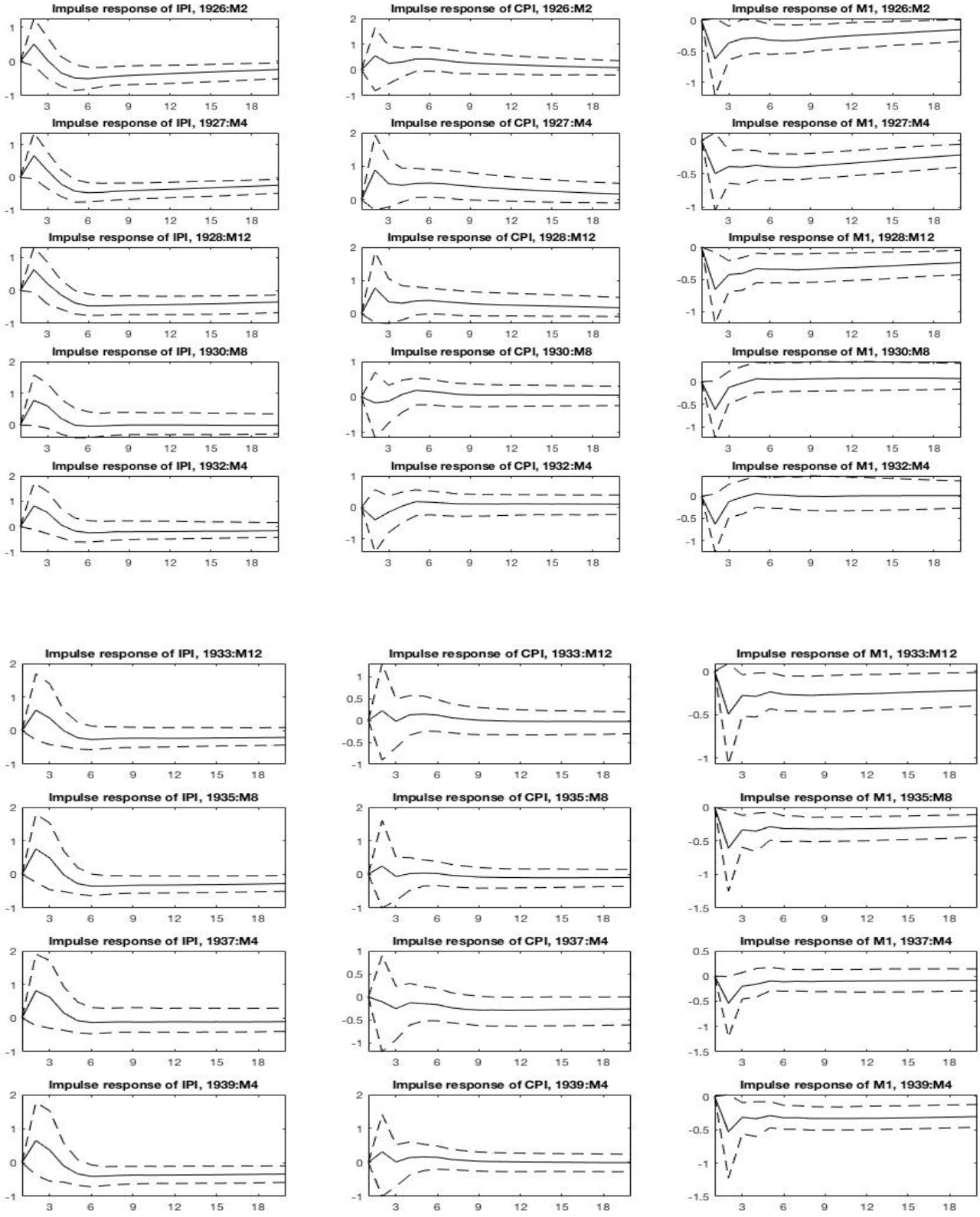


Figure 5.1– Impulse responses to a discount rate shock. IPI, CPI and M1 in columns 1, 2 and 3 respectively. Note: The solid lines depict the 50-th percentile with the 16-th and 84-th percentiles for the dashed lines.

becomes negative after two to three months. This time, although the discount rate was above or at the same level as the call loans rate, it was mostly below the inflation levels, avoiding an initial negative response. Despite the variations observed, none of the responses are significant (Figure 5.1). The response of CPI inflation to an OMO shock (Figure 4.2) is the same for almost the whole period: initially positive but negative after two months. The exception is from 1927 to the end of 1929 (a deflation period), when it is negative. It corresponds to the Fed's gold sterilization. In general, this figure shows that, for the entire interwar period, open market purchases had an ephemeral effect.

For the years 1930, 1931 and 1932, the Fed purchased more intensively than before but the

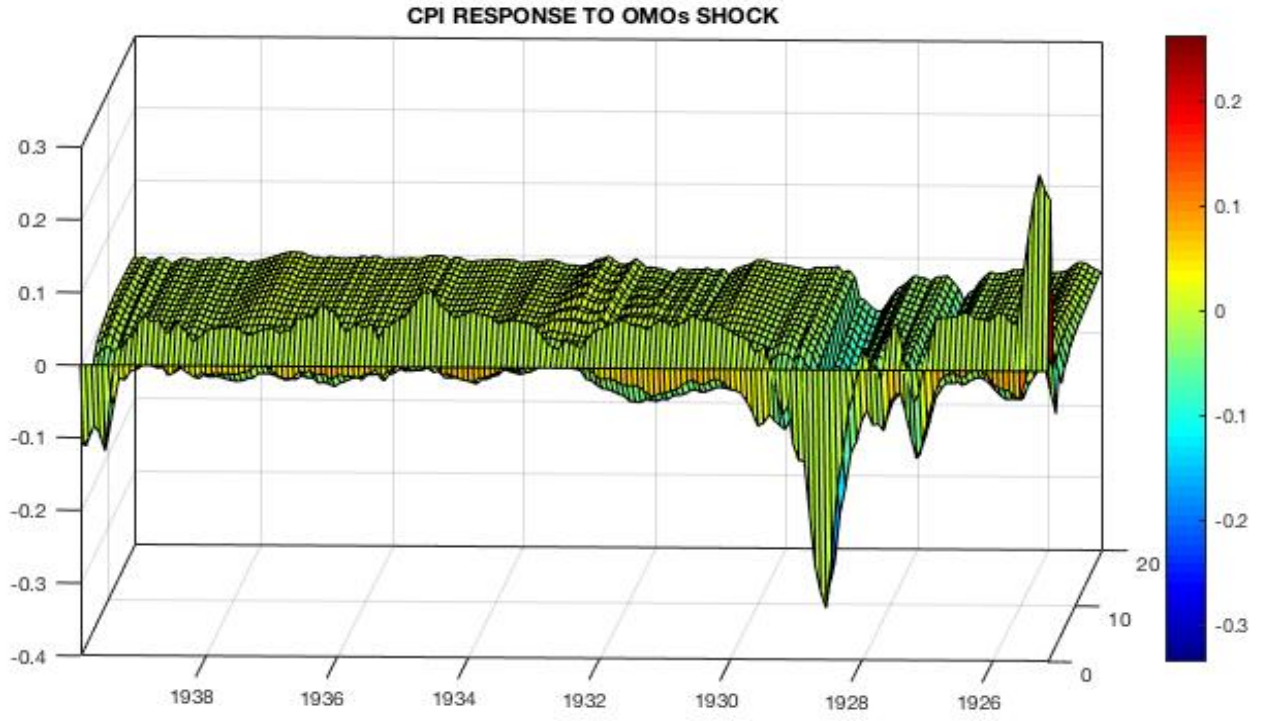


Fig. 4.2 – CPI inflation impulse response to an OMO shock. Note: Posterior means.

consequences of the Great Depression regarding bank failures, a higher demand for excess reserves and currency, and gold outflows offset those purchases. After 1933, the Fed was relegated to the backseat, the Treasury being mostly in charge of the monetary policy. OMO and the discount rate were hardly used since then. These results are supported by Figure 5.2, in which again, a shock to this variable has no significant effect on CPI at any period.

Considering the shock to the new variable C-D (Figure 4.3), the response of CPI inflation varies depending on whether the spread is negative or positive, whether the economy is experiencing inflation or deflation and the position of both rates in relation to the inflation levels.

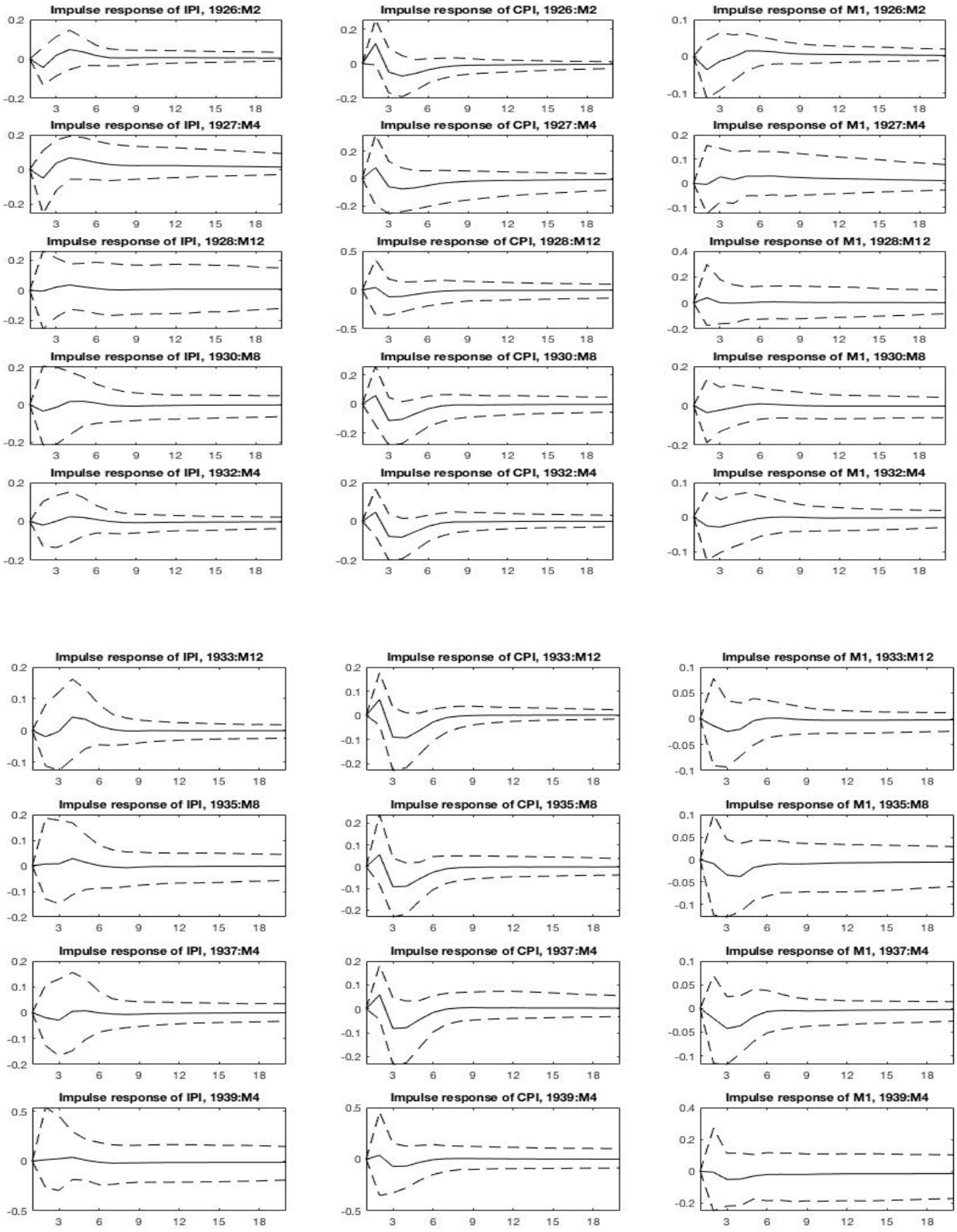


Fig. 5.2– Impulse responses to an OMO shock. IPI, CPI and M1 in columns 1, 2 and 3 respectively. Note: The solid lines depict the 50-th percentile with the 16-th and 84-th percentiles for the dashed lines.

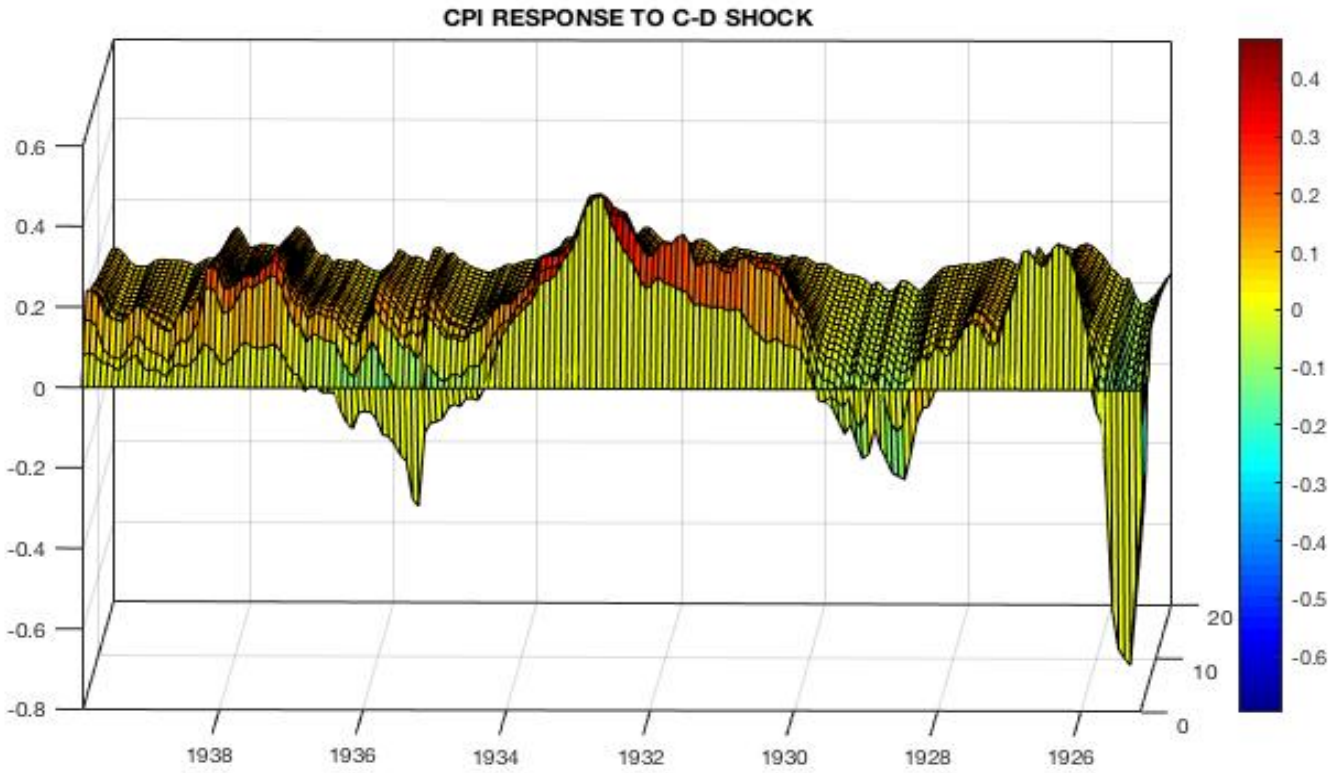


Figure 4.3 – CPI inflation impulse response to a C-D shock. Note: Posterior means.

When the spread is positive but there is deflation, the response is negative, as for the second half of 1925 and between 1928 and 1929. This could mean that the rates were too high. Consequently, a larger spread, meaning a higher call loans rate in relation to the discount rate would have tightened the economy even more. The response is positive from the beginning of 1926 to the beginning of 1928. This was a period with a positive spread (sometimes quite narrow or zero) until mid-1927, with both rates around the positive levels of inflation. For the last half of 1927, a larger spread would have exerted inflationary pressures, counteracting the deflation triggered by the sterilization of gold. From 1930 to 1933, CPI inflation responds positively to an increase in the spread, as for the last half of 1927, but under a deflationary scenario. For this period, the spread was almost zero or negative. It seems that a positive or less negative spread would have supposed an increase in inflation. Related to the last statement, the highest positive peak during this period occurs around the beginning of 1933, when the short-term rates increased, as seen in Figure 3. However, the Fed did not allow them to be above the discount rate. For the rest of the subperiod, the response is mostly positive.

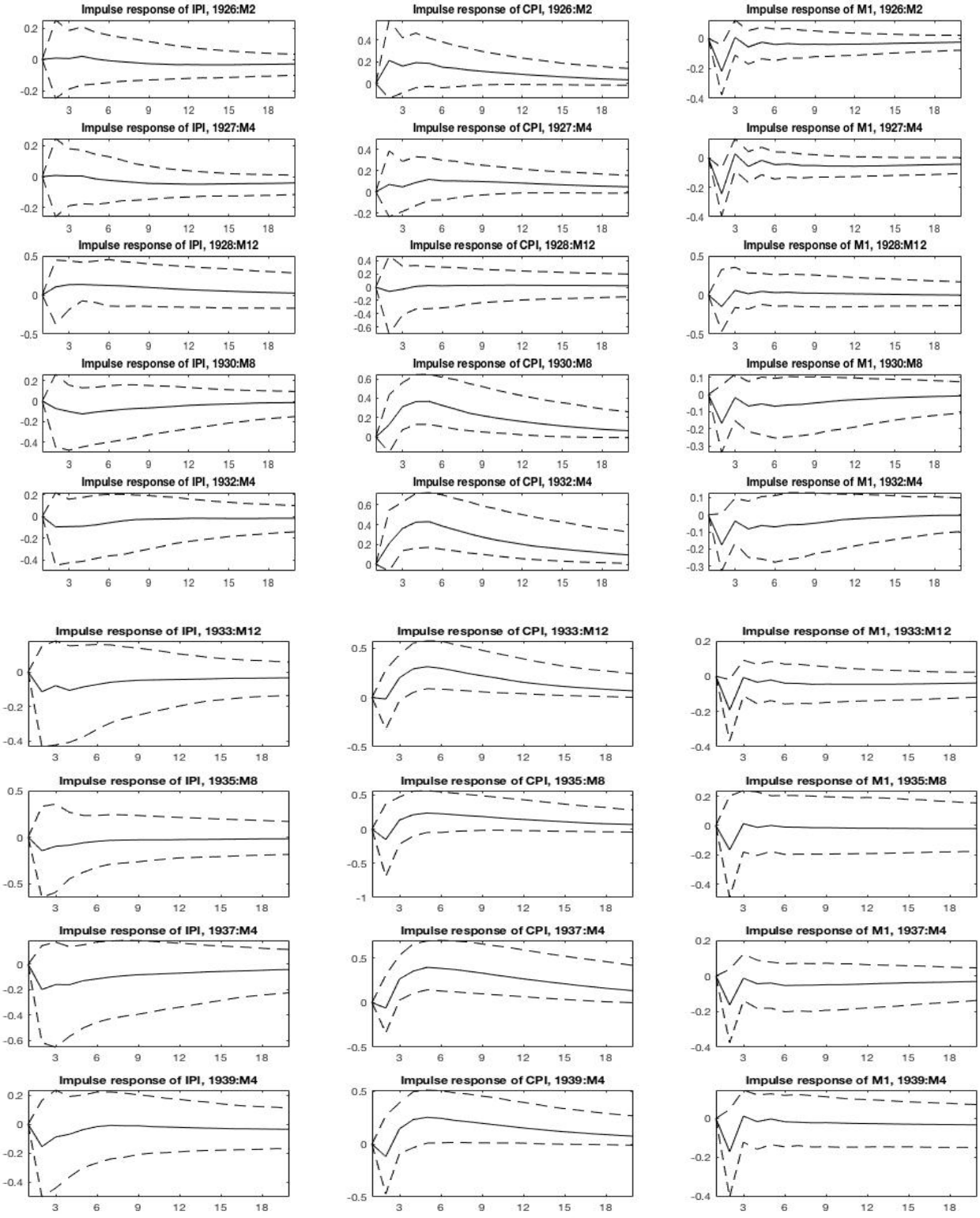


Figure 5.3– Impulse responses to an C-D shock. IPI, CPI and M1 in columns 1, 2 and 3 respectively. Note: The solid lines depict the 50-th percentile with the 16-th and 84-th percentiles for the dashed lines.

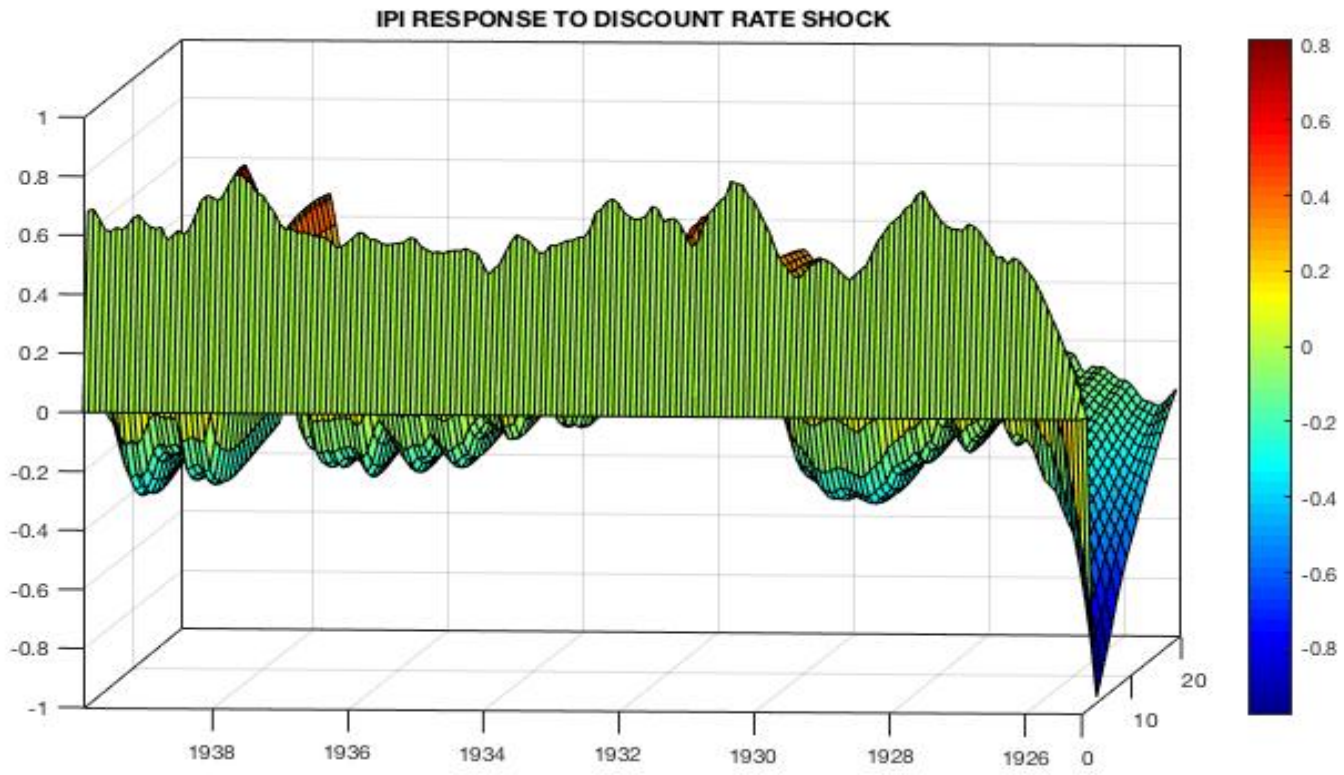


Figure 4.4– IPI impulse response to a discount rate shock. Note: Posterior means.

During those years, the spread was zero or negative, but both interest rates were below inflation most of the time, which did not contribute to reducing it. For this shock, the response is significant, approximately, for the period 1930-1934 and again around 1937 (Figure 5.3). In both cases, the spread was negative and there was deflation. Therefore, a lower discount rate in relation the short-term rate would have increased inflation. The responses are significant from the second or forth month and last beyond twenty months.

Focusing now on the responses of the IPI, a shock to the discount rate (Figure 4.4) produces quite a homogeneous response for the entire period. The response is initially positive but becomes negative after two months. The only difference occurs from 1930 to 1932, when the response never becomes negative. Gold inflows and open market purchases could be the reason, along with the great decrease in the discount rate. In general, either the transmission mechanism of the discount rate towards the output needs more time to materialize or the use of two lags with monthly data may not be enough to capture the real effect. Furthermore, its impact is not significant for the entire period (Figure 5.1). A shock to OMO (Figure 4.5) has, mostly, a positive impact. There is an exception from 1926 to 1930, when the initial response is negative for two months before turning positive. This figure has a similar pattern to the response of inflation to an OMO shock (Figure 4.2).

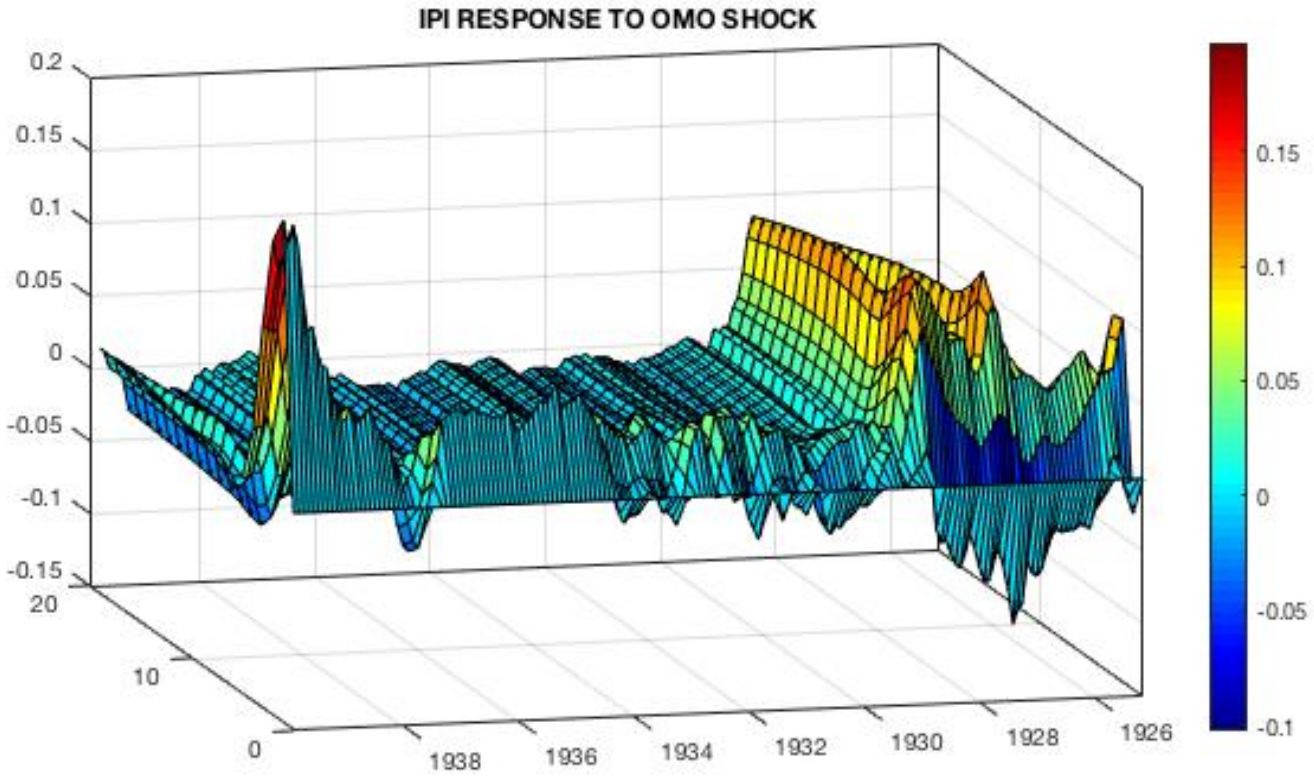


Figure 4.5– IPI impulse response to an OMO shock. Note: Posterior means.

Regarding the positive peak seen at the end of 1928, it seems that the Fed purchased more in the open market after the crash, but only for some months, because the response becomes less positive for the following periods. This is in line with Appendix D. Once more, its effect is not significant (Figure 5.2). Regarding a shock to C-D (Figure 4.6), the response is mostly positive until 1929. For parts of 1926 and 1927, when the spread was almost zero, the response is slightly negative, although only initially. Afterwards, when the largest spreads are observed, the response is positive again. This positive response also occurs during periods of deflation, meaning that the spread could have contributed to increasing lending and growth, despite the sterilization of gold. After 1930, the response is negative, when the discount rate started to be at the same level or above the call loans rate (Figure 3). Again, the responses are not significant at any period (Figure 5.3). The residuals presented in Figures 6.1 and 6.2 are in line with the narrative described in Appendix D. For the equations of the final targets, namely the IPI and CPI, the residuals are higher during the period in which the Fed was relegated to the backseat, after 1933, suggesting that other variables, which are not the Fed's instruments included in the model (as they were hardly used), could be driving the results of that period. Such factors could be fiscal policies, gold flows or the devaluation of the dollar in 1934. For the CPI equation, the

residuals are also higher from 1925 to 1929 (Figure 6.1), likely corresponding to gold flows. For the residuals of M1, there is a peak at the end of 1929, probably related to the crash, bank failures and holdings of currency, and between the end of 1932 and the beginning of 1933, when more bank failures occurred (Figure 6.1). Apart from those peaks, the residuals are constant for the entire period. For the C-D equation (Figure 6.2), the increase in the residuals appears between 1928 and 1930, when the difference between rates was the largest and the Fed was unable to reduce the call loans rate because other institutions were giving credit. Regarding the OMO and discount rate equations, the residuals behavior is similar to the C-D equation, but they start to decrease in 1932 (Figure 6.2). That means that the Fed was targeting other variables beyond those included in the model while in charge of monetary policy. According to the narrative, the Fed may have been responding to gold flows or bank reserves. Afterwards, the residuals tend to zero, as the instruments were hardly used. These results are in line with the lack of significance seen in most of the impulses response.

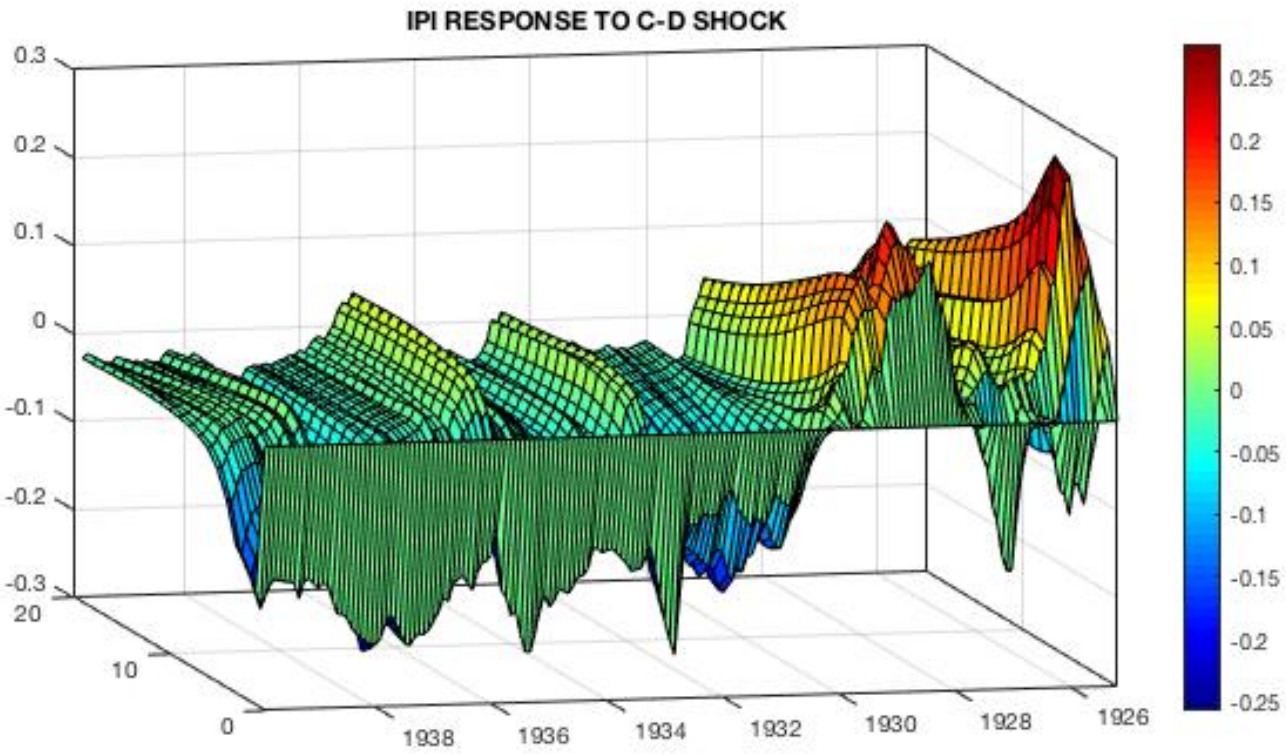


Figure 4.6– IPI impulse response to C-D shock. Note: Posterior means.

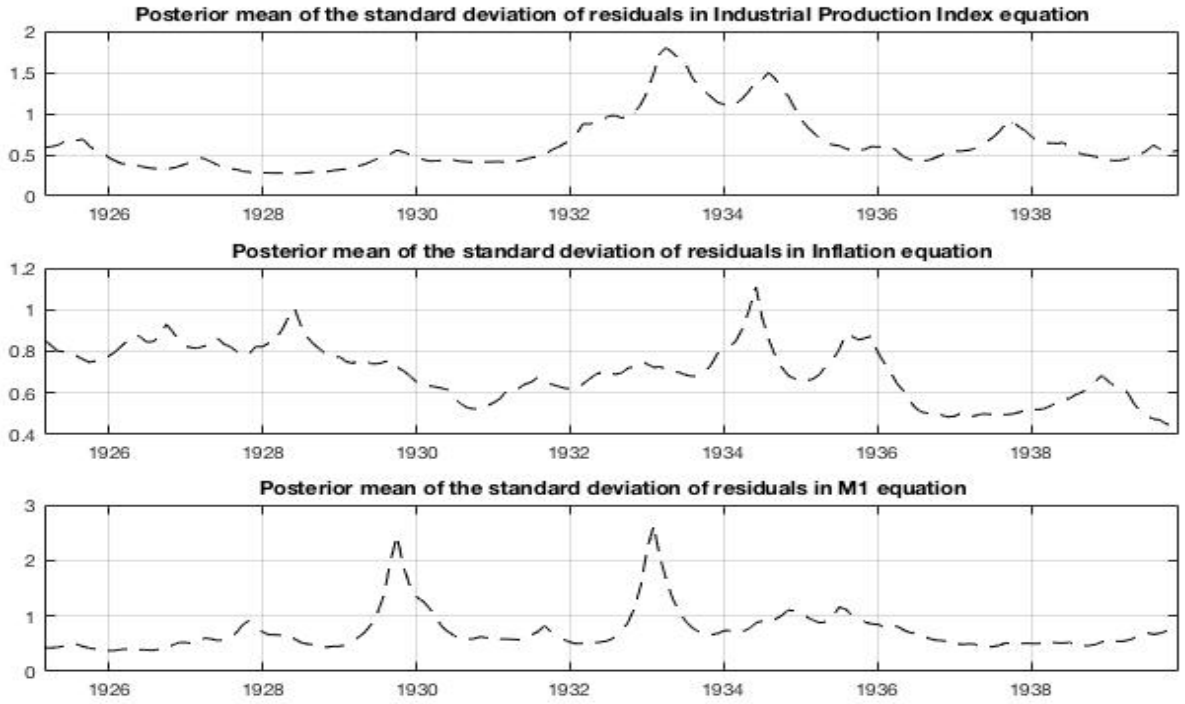


Figure 6.1– Posterior mean of the standard deviation of the residuals in IPI, CPI inflation and M1 equations respectively.

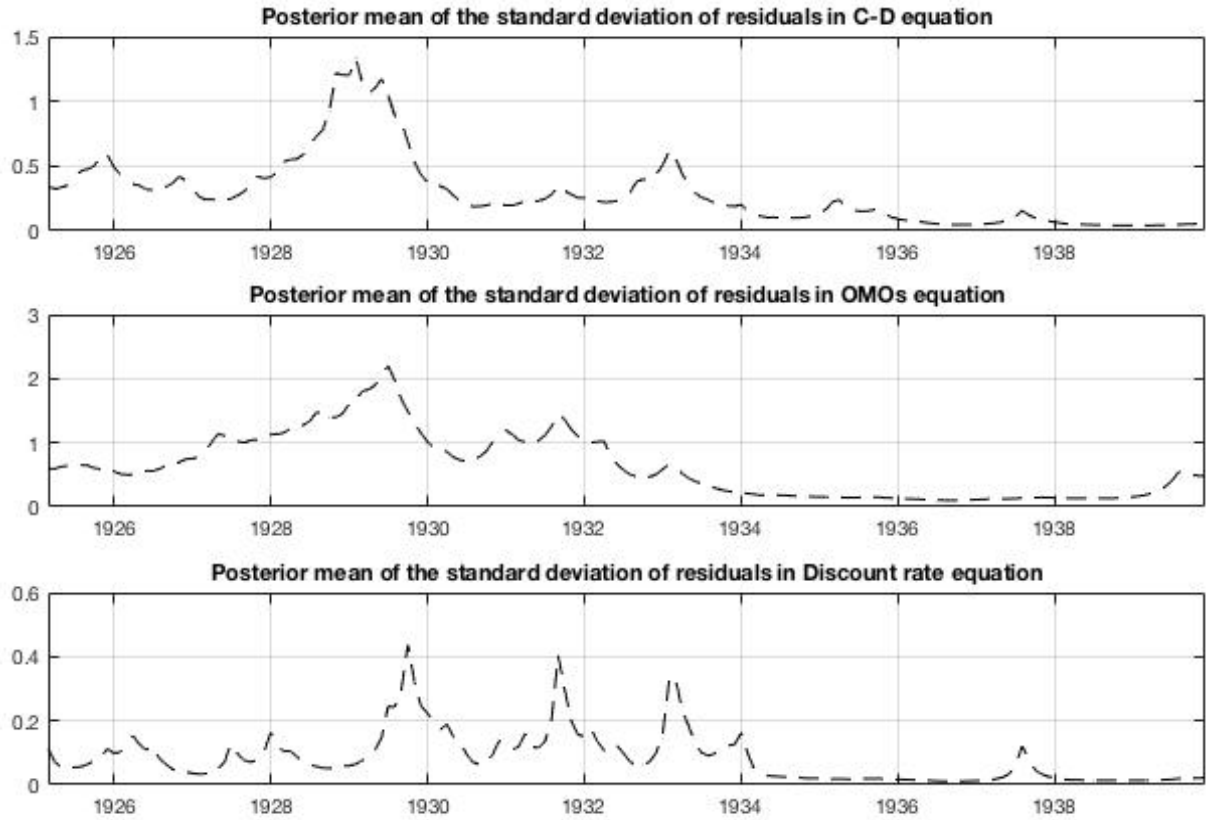


Figure 6.2– Posterior mean of the standard deviation of the residuals in C-D, OMO and discount rate equations respectively.

5.2 1958:I–2007:IV[16]

For the impulse response function analysis of this second period, I will only analyze the results obtained with multi-move algorithm with one lag. The results obtained with K-P's algorithm with two lags are very similar. While the figures are not presented, I will comment the relevant variations.

This time, I start by analyzing the response of inflation to an F-D shock (Figure 7.1), as it provides the perfect beginning for the explanation of the next impulse responses. Until 1968, the response of inflation is almost zero, coinciding with the period when the spread between the rates was zero or negative. However, that response is not significant (Figure 8.1). From 1968 to 1982, the response of inflation practically mimics the evolution of the spread (Figure 1). Thus, when it becomes larger, inflation is higher. Those positive peaks are reversed once the spread is zero or negative, and after the federal funds rate has visited maximum levels.

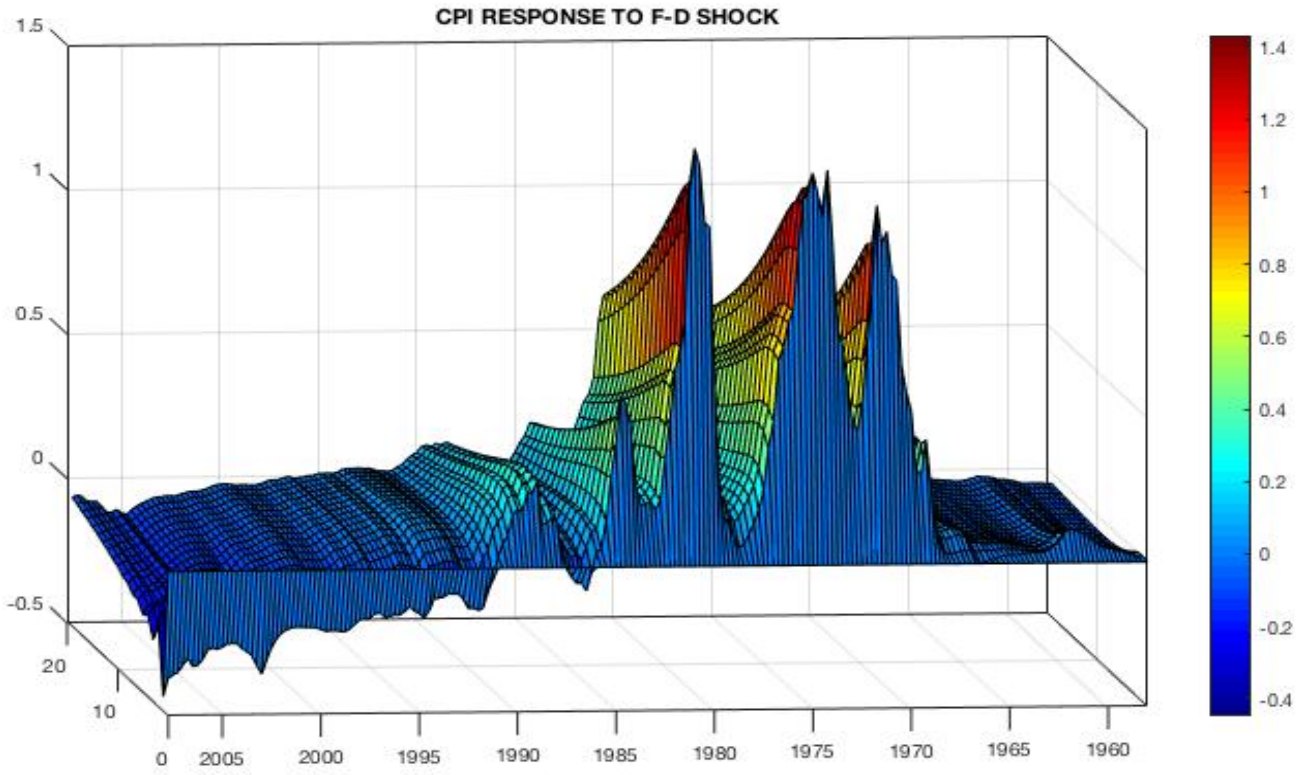


Figure 7.1– CPI inflation impulse response to F-D shock. Note: Posterior means.

[16] The historical context is in Appendix D and the remaining figures in Appendix A.2.

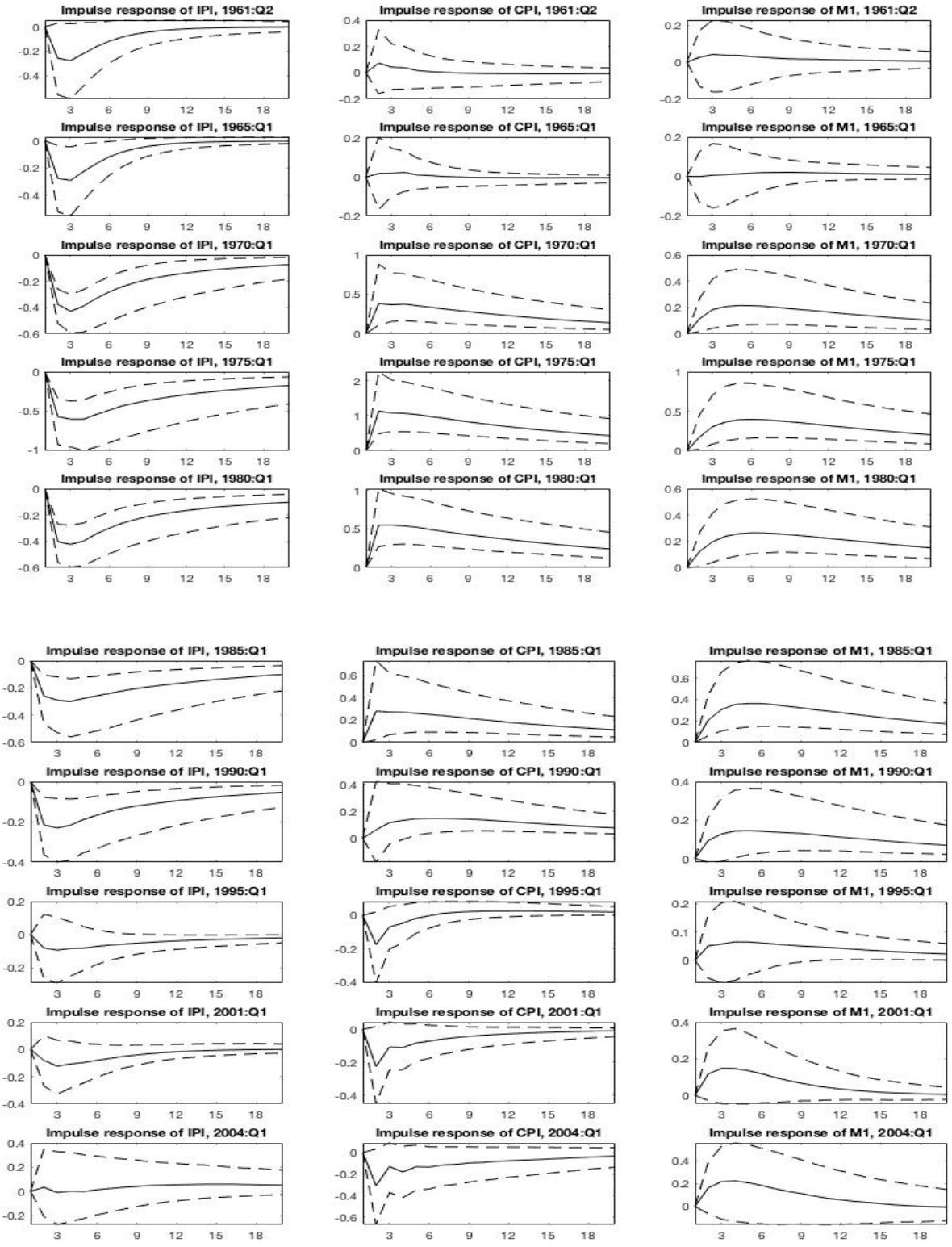


Figure 8.1– Impulse responses to an F-D shock. IPI, CPI and M1 in columns 1, 2 and 3 respectively. Note: The solid lines depict the 50-th percentile with the 16-th and 84-th percentiles for the dashed lines.

However, the responses are still positive, as inflation is above both rates. From 1982 to 1990, the pattern is the same. However, despite observing even larger spreads, inflation responses are not as positive as in the 1970s or early 1980s. For these periods of positive spreads, Figure 8.1 shows that the spread has a significant and long-lasting impact on inflation. Shortly after 1990, around mid-1992, the response of inflation turns negative until the end of the sample. It could be expected that, at least in 2001 and 2002, or even 2003, the response of inflation would be positive given that inflation is above the discount and federal funds rate, or from 1994 to 2000, when, despite not being large, the spread is positive. However, this does not happen and coincides with the decrease in borrowing observed in Figure 2. Besides, the responses are not significant for this last period (Figure 8.1).

Encouraged by this regime change, I discovered some literature that sheds light on it. In the Federal Reserve Bulletin of November 1994, Clouse (p. 965), apart from supporting the fact that a larger spread led to higher borrowing and that the relationship was quite stable until 1980, given the failing bank situation during the 1980s and 1990s, stated:

> … changes became evident during the 1980s in the willingness of healthy institutions to turn to the discount window. Many banks apparently became more reluctant to turn to the window for fear of provoking market concerns about their financial condition. The greater reluctance to borrow weakened the historical relationship between the discount borrowing and the spread of the federal funds rate over the discount rate.

Furthermore, "This reluctance became acute during the economic downturn in the 1990-1991 …" (Clouse 1990, p. 969). Kasriel and Merris (1982) added that the Fed, before 1979, did not pay attention to borrowed reserves and the relation between the discount window and the federal funds rate. Pearce (1993) showed that the relationship between borrowing and the spread changed under different target regimes. Thus, from January 1975 to October 1979, under a federal funds rate target, there was a strong nonlinear relationship between the spread and borrowing, whereby a larger spread led to higher borrowing, although to a certain extent.[17] From October 1979 to October 1982, under a nonborrowed reserve targeting procedure and lagged reserve accounting,

[17] Peristani (1991) found an S-shaped pattern when analyzing the period 1959–1988. Thus, although the spread led to higher borrowing, when the difference was around 4%, borrowing hardly, if at all, increased.

the relationship weakened and the amount of borrowing decreased. Last, after October 1982, under a borrowed reserve targeting procedure and contemporaneous reserve accounting, the relationship was even weaker and the borrowing decline more pronounced. Therefore, it seems that this negative no significant response and regime switch indicate that some factor related to the banking sector triggered that positive spreads did not increase inflation. Figure 7.1 also shows that, as commented in the introduction, the "price puzzle" is non-existent, because inflation increased with rises in the federal funds rate, mostly when the spread was positive and borrowing increased. Therefore, there is no puzzle but an inadequate Fed's policy by allowing those positive spreads. The response of inflation to an OMO shock (Figure 7.2) is negative until 1967, with the spread being generally negative or zero. Thus, it seems that while the Fed did not target short-term rates, purchases in the open markets were scarce to boost inflation. Since then, under an interest target and in line with the figure analyzed previously, positive peaks occur for those periods when the spread was positive. This means that, despite banks already were borrowing, taking advantage of that spread, the Fed purchased (although perhaps in a relatively smaller proportion than when the spread was zero or negative) in the open market,

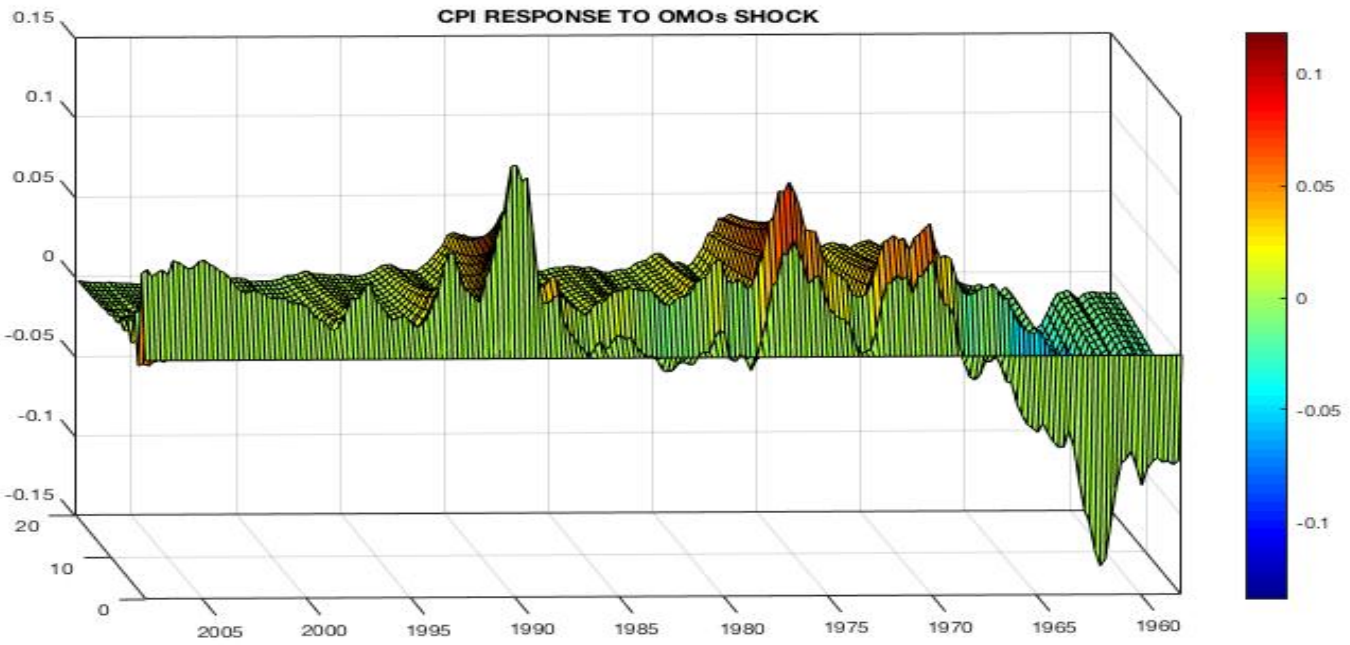


Figure 7.2– CPI inflation impulse response to an OMO shock. Note: Posterior means.

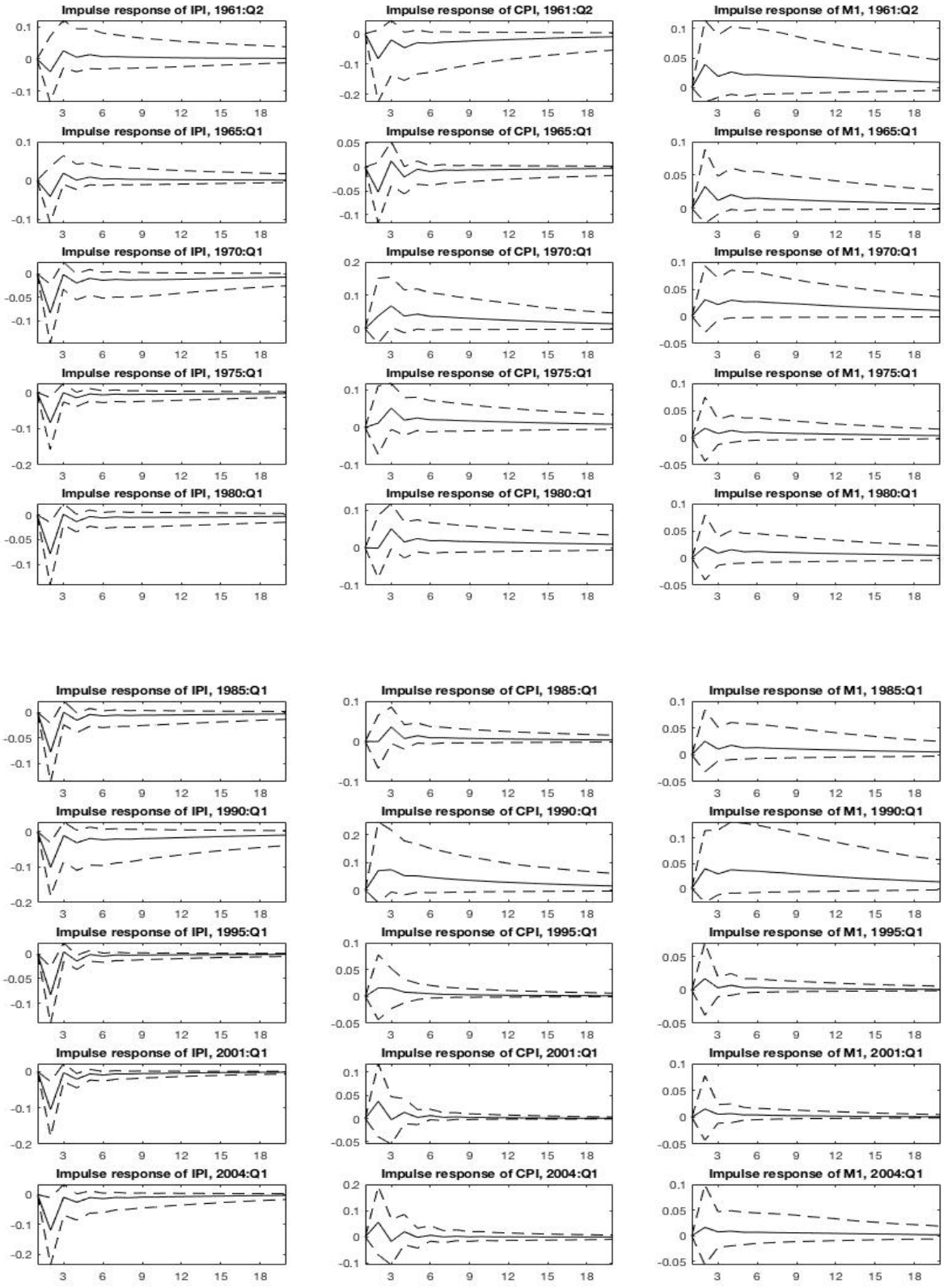


Figure 8.2– Impulse responses to an OMO shock. IPI, CPI and M1 in columns 1, 2 and 3 respectively. Note: The solid lines depict the 50-th percentile with the 16-th and 84-th percentiles for the dashed lines.

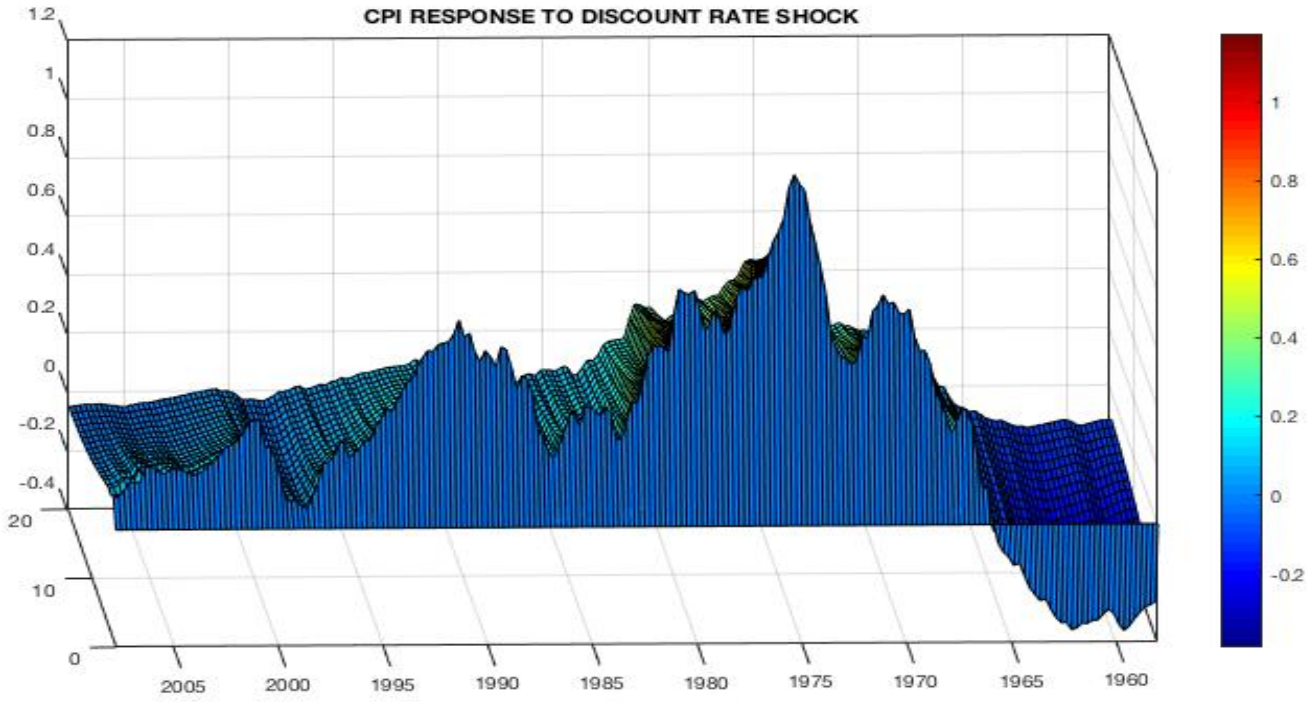


Figure 7.3– CPI inflation impulse response to a discount rate shock. Note: Posterior means.

contributing even more to increasing inflation. Nonetheless, the responses are not significant for the entire period (Figure 8.2). The results above support the response of inflation to a discount rate shock (Figure 7.3), which is not expected. Its response is negative until 1966, a period when the discount rate is either above or equal to the federal funds rate. For the first row in Figure 8.3 (1961:Q2), the response is slightly significant. Afterwards, the response becomes positive either because, when the spread was narrow or negative, the Fed offset the rises in the discount rate by increasing its purchases in the open market (although in those cases the positive response was reduced) or because, when the spread was positive, the Fed exacerbated the amount of borrowing at the discount window with more purchases. Since positive spreads emerged, the discount rate has a positive and significant impact on inflation, except for the last years of the sample, when the response is not significant (Figure 8.3). It is important to highlight that since 2003, the discount rate was set above the federal funds rate as a penalty rate, but it allowed borrowing with no question asked.

The response of the IPI to an F-D shock (Figure 7.4) is, for almost the entire period, negative and almost proportional to the levels of the federal funds rate. The lowest peaks coincide with the highest federal funds rates. Almost similar to inflation, the response is

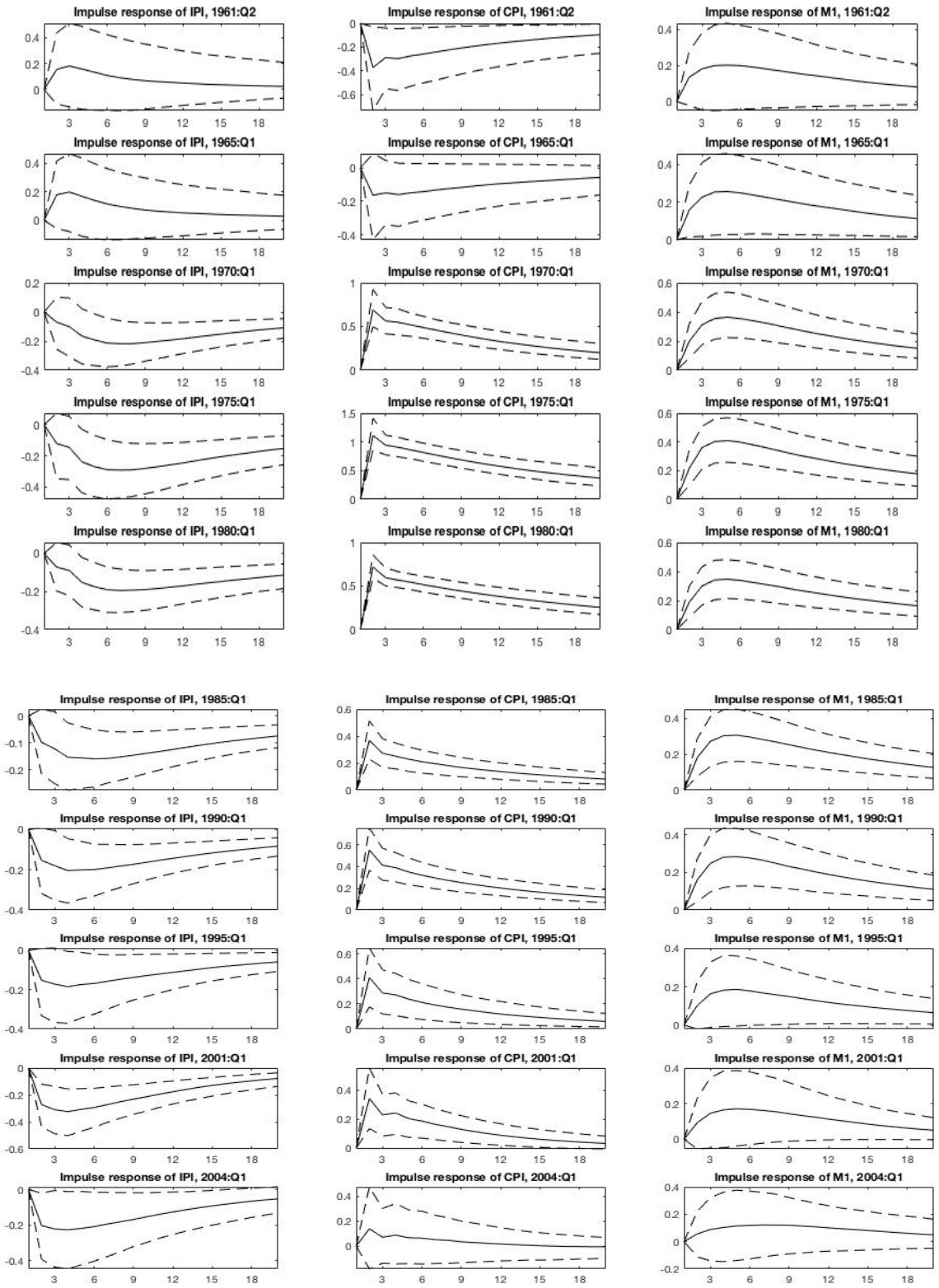


Figure 8.3– Impulse responses to a discount rate shock. IPI, CPI and M1 in columns 1, 2 and 3 respectively. Note: The solid lines depict the 50-th percentile with the 16-th and 84-th percentiles for the dashed lines.

significant from the mid-1960s to the mid-1990s, with an horizon of two years or more (Figure 8.1). For the discount rate shock (Figure 7.5), the response of the IPI is positive until 1965 and then becomes negative. Since then, as in the last figure, the negative peaks occur around the highest peaks of the federal funds rate. For this case, however, the impact is not proportional since the beginning of Volcker's era. After approximately 1970, the responses are significant, although most of them just after some quarters (Figure 8.3).

Regarding the response of the IPI to an OMO shock (Figure 7.6), it is negative with the exception at the beginning of the sample, when it becomes positive after two quarters. Similar to the last figure, the responses are mostly significant after 1970, although this time they are weak and only for one quarter (Figure 8.2). This response is not expected. As explained for Figure A.7.11 in Appendix A.2, the transmission between the two variables may need more lags, because for those periods when lending was decreasing as a consequence of the high rates, what also led to a decline in output, the Fed would have been purchasing more securities to decrease interest rates.

To sum up, a regime change is observed around 1965, when the Fed began to pay attention and target short-term rates. The other regime change, although represented not in the instruments' impulse responses but in the spread, is around 1990. Although the figures of the instruments mostly maintain their sign and shape since 1965, this happens under different

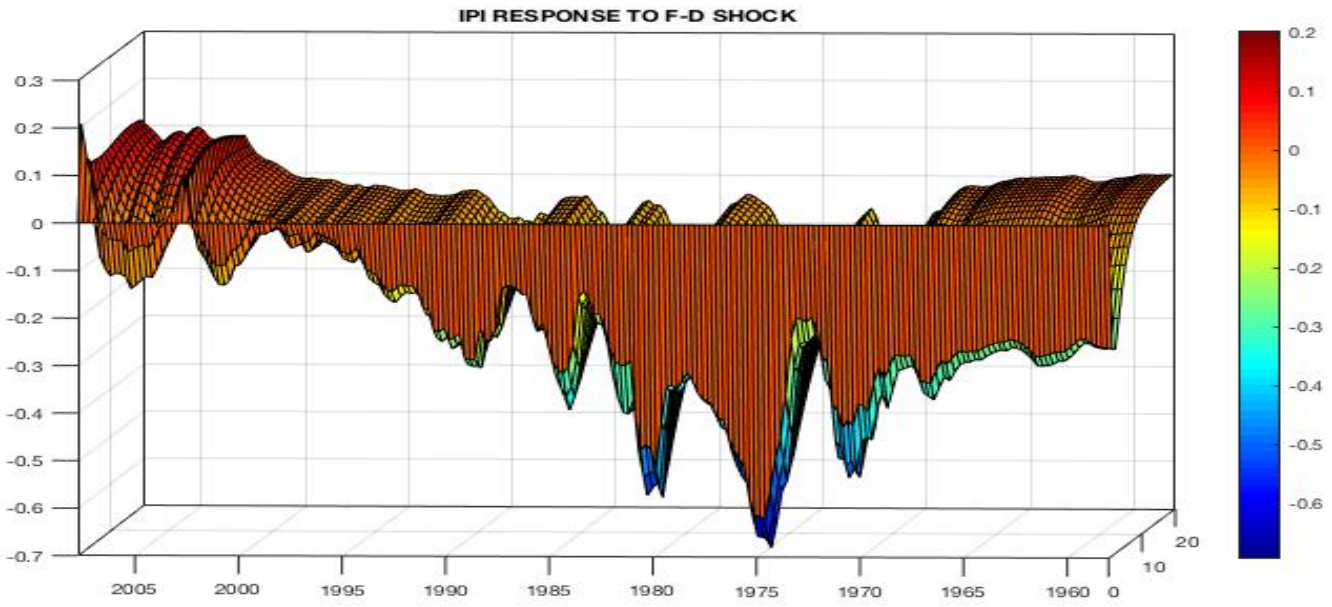


Figure 7.4– IPI impulse response to a F-D shock. Note: Posterior means.

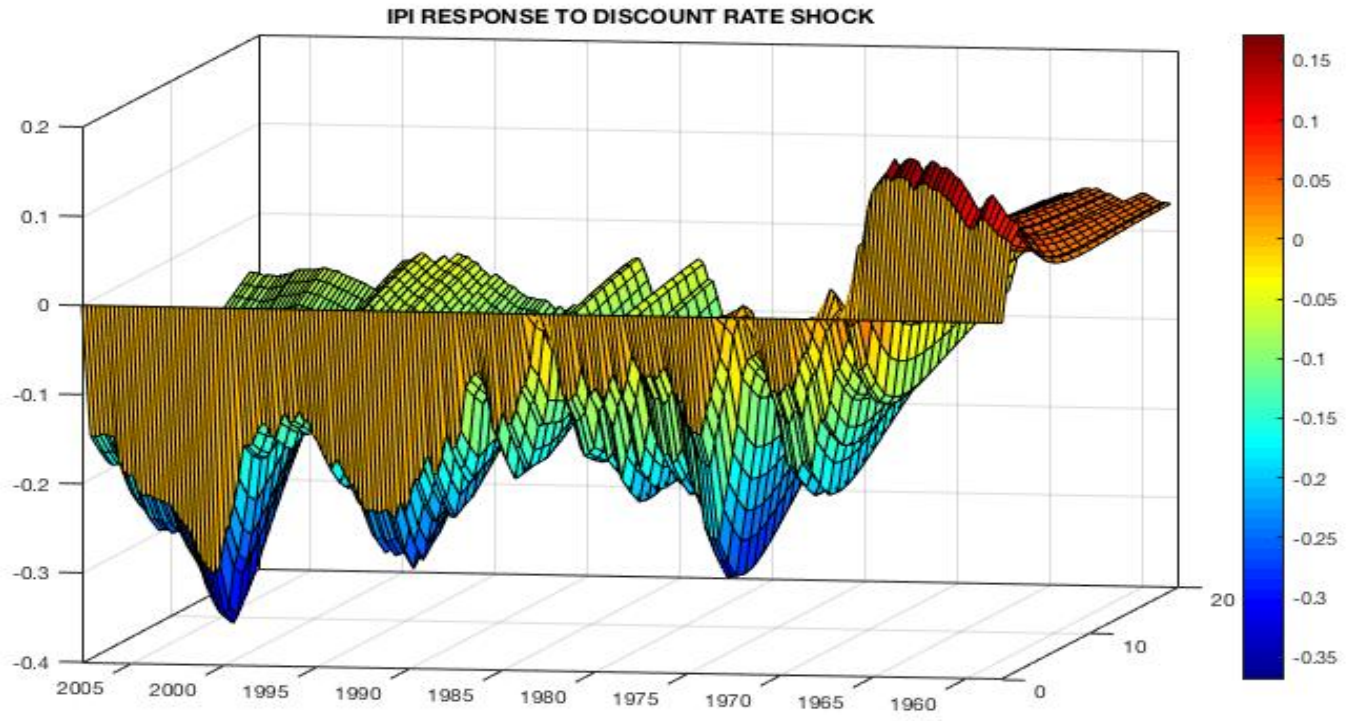


Figure 7.5– IPI impulse response to a discount rate shock. Note: Posterior means.

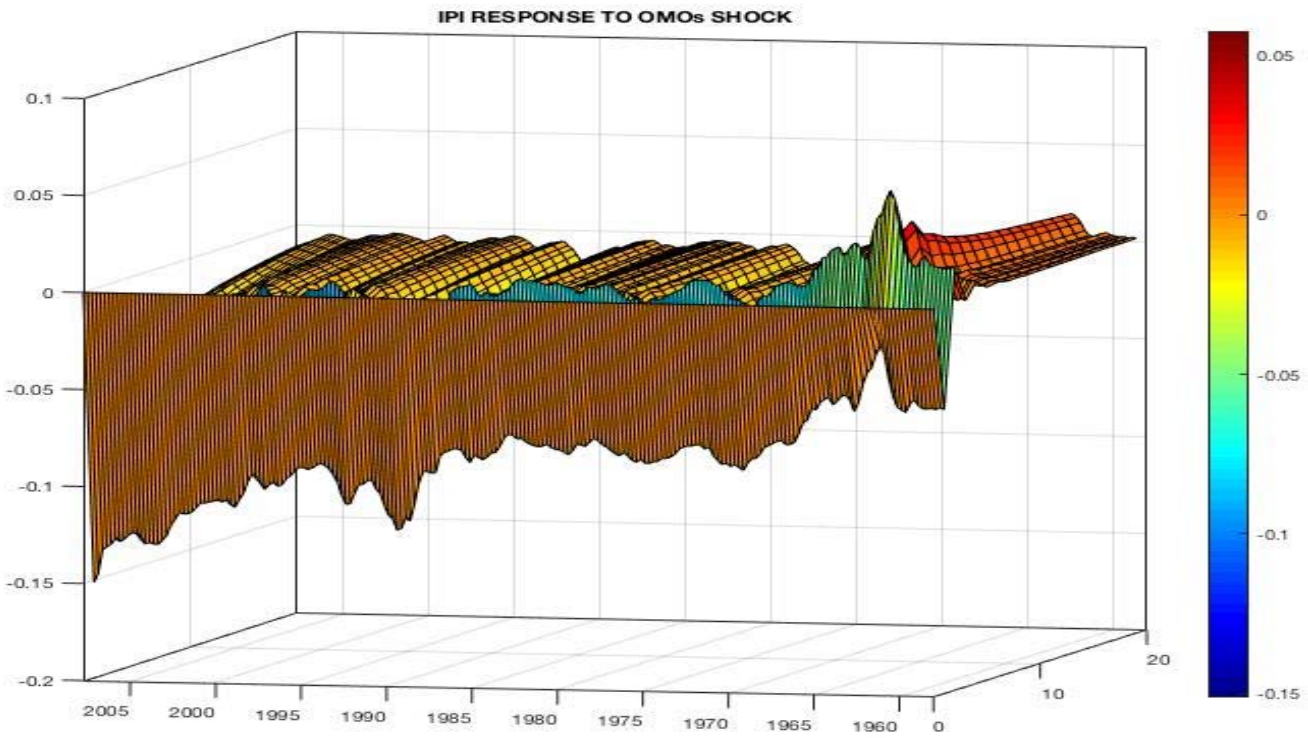


Figure 7.6– IPI impulse response to an OMO shock. Note: Posterior means.

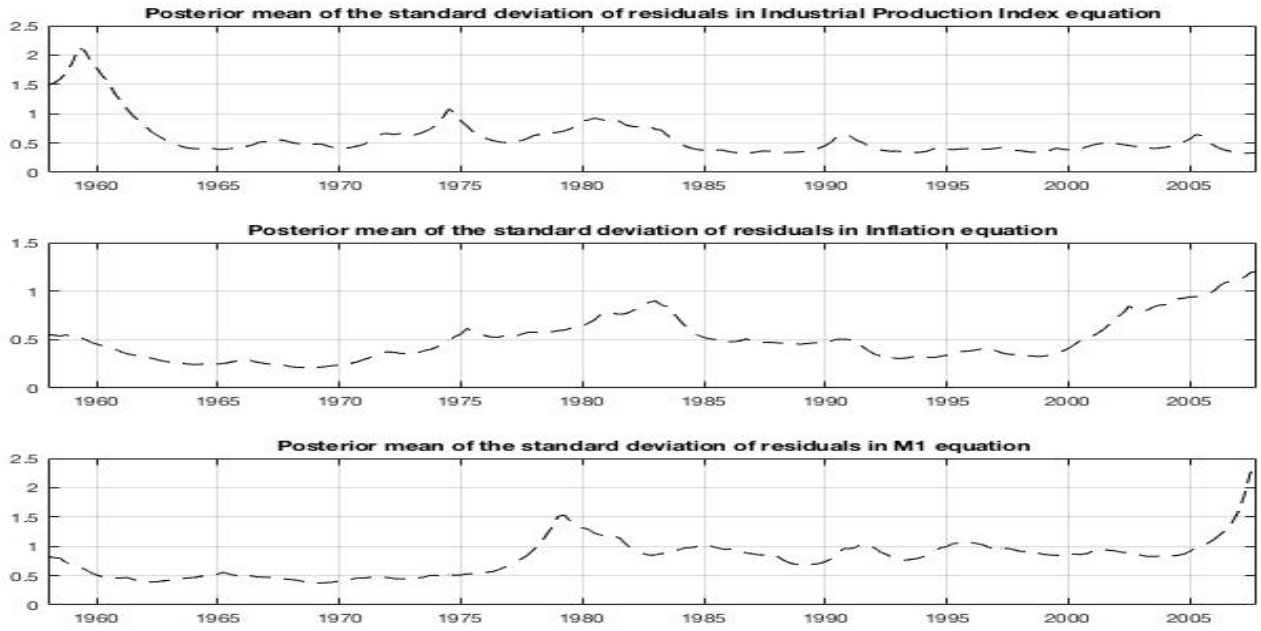


Figure 9.1– Posterior mean of the standard deviation of the residuals in IPI, CPI inflation and M1 equations respectively.

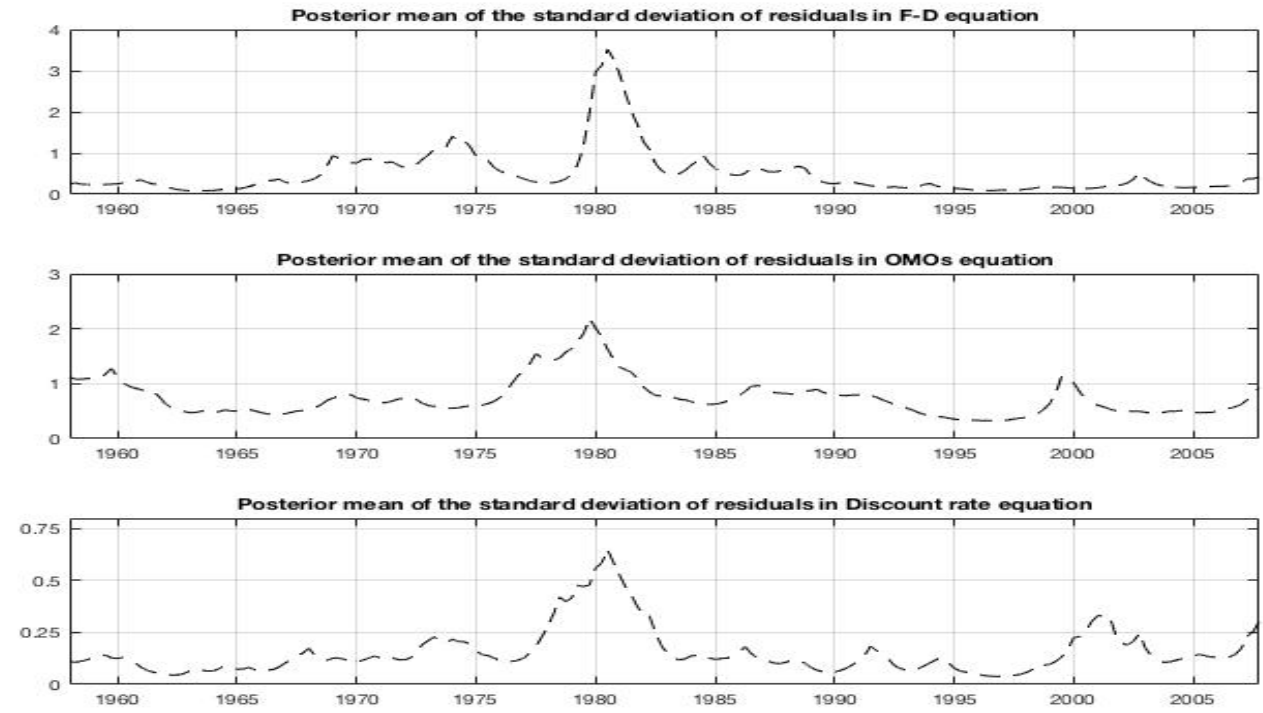


Figure 9.2– Posterior mean of the standard deviation of the residuals in F-D, OMO and discount rate equations respectively.

circumstances. Therefore, a change in the banking sector's behavior seems to be the most likely explanation. This statement is supported by the counterfactual exercise developed in Appendix B, where I find no variation in how the Federal Reserve applied its policies for the period under analysis, and where inflation expectations are also taken into account.

For the residuals of the IPI equation (Figure 9.1), an increase is observed at the beginning of the sample, which quickly disappears. Thereafter, the residuals maintain roughly the same levels, being slightly higher in the 1970s and the first half of the 1980s. For inflation (Figure 9.1), the residuals increase in the 1970s and at the beginning of the 1980s. This is a period when money growth or some type of reserve measure was supposedly targeted. The residuals decrease until 2000, to increase again until the end of the sample. For M1 (Figure 9.1), the residuals increase in the second half of the 1970s, remain at roughly the same levels until 2005 and then rise again. While, for the IPI behavior, external shocks could have determined the results at the beginning of the sample and slightly during the 1970s and part of the 1980s, the residuals of the inflation equation show that external shocks could affect the results in the 1970s and since 2000. The same is applicable to M1. Bank reserves and banking sector's behavior, expectations, fiscal policies, exchange rate or political pressures are factors that are not included the model and could have influenced the results. For the equations of the Fed's instruments (Figure 9.2), the 1970s also seem to be a period when external shocks could have influenced their behavior, as the Fed may have been aiming other targets. The same applies to the small peak around 2000, and the rise since 2006.

5.3 Alternative identifications

For both periods, alternative orders were tested by locating OMO the first and third in the VAR. While most of the responses to an OMO shock change and remain no significant, the relationships between the other variables stay almost identical. Another identification scheme was tried allowing the instruments and the spread to react contemporaneously to each other and imposing zeros in some of the relationships between OMO and the spread with M1 and the final targets (so that the decomposition of the variance covariance matrix was no longer lower triangular), using the algorithm developed in Canova and Forero (2014). However, none of the draws overcame the stationary restriction and the exercise could not be carried out.

6. What lessons can we learn?

The picture of monetary policy in the U.S. for the last century shows some recognizable patterns in the instruments of monetary policy and intermediate and final targets. Before

analyzing the instruments individually, from a general perspective according to the results, the Fed's instruments were not the main drivers of the American economy's performance for the interwar period, while for good or for bad, they gained relevance for the second period. The lack of significance obtained for the interwar period is supported with some of the facts described in Appendix D, such as the Fed's inability to differentiate between nominal and real interest rates, the lack of experience operating in the open market or the period when the Treasury took the responsibility for monetary policy. Also, as commented in the literature review, it seems that gold flows had an important role in determining the path of the economy. Focusing now on the instruments, I start by analyzing the discount rate. Its impact on inflation varies according to two scenarios. First, when it is above the short-term rate and above inflation levels, its impact on inflation is negative. There is an exception for the last years of the sample, when its impact is positive but not significant, coinciding with the increase in the residuals of the inflation equation. Therefore, other factors could be distorting that relationship for those years. The second scenario occurs when the discount rate is below the short-term rate, the inflation levels or both. In this case, inflation responds positively. While these patterns were also found for the interwar period, the results displayed for the residuals and the narrative analysis, seem to explain why those impulses responses are not significant for that period. For the IPI, when the discount rate impact has a significant response (what happens only after 1965), its sign is negative. From 1958 to 1965 the response is positive as in the interwar period, although in this last case, the sign is negative after some months. In any case, those responses are not significant. The conclusion here is that while no other factor is influencing the relationship discount rate-output, increases in the discount rate should decrease output. Last, the M1 response is different for each period and could be related to the different Fed's procedure about OMO and targets. One the one hand, for the interwar period (negative and significant response) when purchases in the open market were scarce, the discount rate had a more important impact on short-term rates and therefore, on M1. The reason is that short-term rates, conditioned on the discount rate but not manipulated by the supply of reserves with OMO as under an interest target, responded directly to demand forces, influencing the path of M1. On the other hand, around 1965 (positive significant response) the Fed began to target short-term rates, what required a more intensive use of OMO. As the raises in the interest rates intended to reach the Fed's target were insufficient to restrain the demand for credit and inflation continued increasing, to keep the federal funds rate under its target, more purchases were needed and the money supply increased along with the discount rate. Despite the more "natural" relationship between interest rates and the demand forces for the interwar period,

unlike under an interest rate target, the use of the discount rate, implicitly and unwittingly, conditioned short-term rates anyways. This mechanism makes both periods comparable despite the different targets and short-term rates.

Evaluating the spread, it is the only one having a significant response for both periods in relation to the inflation levels. A shock to this variable shows different responses depending on the sign of the spread, whether both rates are below or above inflation levels and whether those levels are positive or negative. When the spread is positive or both rates are below the inflation levels, the response is positive. For the interwar period, those two scenarios had a positive but no significant impact on inflation. However, the response was significant and positive as well, when the spread was negative for periods of deflation. This suggests that decreases in the discount rate in relation to short-term rates would have contributed to increasing inflation. The reason why the positive spread had a no significant inflation response for the interwar period is probably due to the fact that real interest rates were too high given the levels of deflation, which were caused by other factors such as gold sterilization. For the second period, the analysis shows that positive spreads above inflation levels contributed to increasing inflation. Moreover, it is likely that the banking sector changed its behavior around 1990, because the positive and significant responses turned negative and no significant even for periods with positive spreads. The different Fed's procedures explained previously, together with the positive and significant responses of inflation when the spread was positive, are in line with the fact that M1 responded positively and significantly to positive spreads, despite it implied higher rates. Regarding the IPI, increases in the spreads are negative and significant only for the period 1965-1990, unlike the discount rate case, in which that significant and negative impact was extended to the end of the sample. Therefore, the spread itself seems to not decrease output, and the high inflation levels related to that spread could be the cause of that negative impact.

Last, although OMO has a significant impact on the IPI for some periods after 1965, they are ephemeral and weak. Therefore, the results suggest that monetary policy can be transmitted through prices but not quantities. That is, even though the amount of money supplied will drive short-term rates in the first submarket, only interest rates will determine the demand for money in the second submarket.

These lessons also provide an explanation for the price puzzle, a problem that has occupied the literature for years. Apparently, a shock to the federal funds rate produces, at least initially, a

positive inflation response. It has been argued that missing variables and the consequent lack of information in VARs produce the so-called "price puzzle." According to the results obtained for the second period (Figure 7.1), most of the increases in the federal funds rate were accompanied by large spreads. This led to an increase in money growth and inflation because banks could borrow cheaper reserves at the discount window and set a relatively lower loans rate. This would trigger a lower restrain in credit than the intended by the Fed. Thus, there is not a price puzzle but a real positive relation between the increase in the federal funds rate and inflation as a consequence of the bad policies that allowed positive spreads.

Last, Primicery (2005) used unemployment, inflation and the federal funds rate in his model and concluded that the change in policies did not differ between the pre- and post-Volcker periods, and no regime switch was observed. According to the counterfactual, I reach the same conclusion regarding the change in policies for those periods; however, I observe two regime switches. The first one is around 1965 in OMO and the discount rate. The second regime switch appears in the F-D spread around 1990. In the latter case, it seems probable that the responsibility could belong to the banking sector. Apart from that, while Primicery obtained standard deviations of the residuals of the CPI inflation equation three times higher in the 1970s than at the beginning of the sample, here they are smoother, increasing in 1975 by only half of the levels seen in the 1960s. Therefore, it seems that the inclusion of the spread along with the instruments explains a great part of the inflation behavior.

7. Conclusions

A re-evaluation of the mechanisms operating between the Federal Reserve's policies and its intermediate and final targets is undertaken in this paper, from nearly the birth of the Federal Reserve to the period before the Great Recession. For that purpose, however, the standard procedure to evaluate monetary policy is questioned and declared erroneous, given the measuring problems associated to the use of intermediate targets as Fed's instrument, and a new procedure is proposed. This new procedure uses the actual instruments and the spread between short-term rates and the discount rate. Thus, a TVC-BSVAR was performed, applying the algorithms already used by Primiceri (2005) and Koop and Potter (2011). To gain a better understanding of the results obtained, they were contrasted with a narrative review of the Federal Reserve's history. Summing up, the Fed's lack of knowledge and inactivity for the interwar period, supported by the results, indicated that monetary policy was unable to influence output and inflation for that period. After 1958, monetary policy gained power to

influence the path of the American economy. However, the management was inadequate and the results showed that increasing the federal funds rate is not enough to decrease inflation. The increase in the federal funds rate should be accompanied by discount rate increases, avoiding positive spreads. Otherwise, they will provide profitable opportunities for banks, triggering an increase in borrowing, and preventing enough restrain in the demand for loans. The mechanism behind these relationships is that as banks obtained cheaper reserves at the discount window, they were likely to raise the loans rate less in relation to the increases in the federal funds rate. Consequently, the demand for credit was not restrained as much as the Fed intended. These facts deny the existence of the "price puzzle," as the increase in inflation when the federal funds rate was raised was due to bad policies by allowing those positive spreads. In the case of aiming to reduce output, it seems sufficient to increase the discount rate. Last, the results suggest that the monetary policy transmission channel is effective only through prices, even though those prices are driven by quantities and other prices. That is, OMO can modify short-term rates, but in the end, the demand side will respond to the price at which money is supplied, namely, the loans rate influenced by the short-term rate and the discount rate. These results leave open questions for future research as a consequence of the regime changes observed around 1965 and 1990. What is the role of the banking sector in transmitting to the real economy the monetary policies undertaken by the Fed? Could bank determine the impact of monetary policy regardless of the Fed's intentions and to what extent?

Bibliography

Ahmadi, P. A., and Ritschl, A. (2009). Depression Econometrics: A FAVAR Model of Monetary Policy during the Great Depression. *SFB 649 Discussion Paper 2009-054.*

Barth III, M. J. and Ramey, V. A. (2001). The Cost Channel of Monetary Transmission. *NBER Macroeconomics Annual 2001* Volume 16, Bernanke and Rogoff 2002.

Benati, L., and Surico, P. (2009). VAR Analysis and the Great Moderation. *American Economic Review*. 99 (4): 1636-1652.

Bernanke, B.S. (1983). Non-monetary Effects of the Financial Crisis in the Propagation of the Great Depression. *American Economic Review* 73, 257-276.

Bernanke, B.S. (1995). The Macroeconomics of the Great Depression: A Comparative Approach. *Journal of Money, Credit and Banking* 27 (1): 1-28.

Bernanke, B.S., and James, H. (1991). The Gold Standard, Deflation and Financial Crisis in the Great Depression: An International Comparison. R.G. Hubbard, ed., *Financial Markets and Financial Crisis*, Chicago: University of Chicago Press, IL 19, 33-68.

Bernanke, B.S., Boivin, J. and Eliasz, P. (2005). Measuring The Effects Of Monetary Policy: A Factor-Augmented Vector Autoregressive (FAVAR) Approach. *Quarterly Journal of Economics* 120, 387-422.

Bernanke, B. S. and Mihov, I. (1998). Measuring Monetary Policy. *Quarterly Journal of Economics* 108 (3): 869-902.

Blanchard, O. and Simon, J. (2001). The Long and Large Decline in U.S. Output Volatility. *Brookings Papers on Economic Activity* 2001 (1): 135-164.

Boivin, J. (2000). The Fed's Conduct of Monetary Policy: Has it Changed and does it Matter? Essays on the Analysis of Changes in the Conduct of Monetary Policy. *Princeton University, PhD Dissertation,* Chapter 3.

Boivin, J., and Giannoni, M. P. (2006). Has Monetary Policy Become More Effective? *Review of Economics and Statistics* 88, 45-462.

---------- (2002). Assessing Changes in the Monetary Transmission Mechanism: A VAR Approach. *Economic Policy Review,*8(1):97 111.

Bordo, M. B. (1993). The Gold Standard, Bretton Woods and Other Monetary Regimes: An historical appraisal. *NBER Working Paper* No. 4310.

Bordo, M. D. and Schwartz, A. J. (1999). Monetary Policy Regimes and Economic Perdormance: The Historical Record. In: *Taylor, J.B. and Woodford, M. (Eds.), Hanbook of Macroeconomics. Elsevier, Amsterdam*, pp. 149-234.

Boschen, J.F. and Mills, L.O. (1995). The Relation between Narrative and Money Market Indicators of Monetary Policy. *Economic Inquiry,* 33 (1): 24-44.

Brunner, K., and Meltzer, A. H. (1968). What Did We Learn from the Monetary Experience of the United States in the Great Depression? *Canadian Journal of Economics*1, 334-348.

Canova, F. and Gambetti, L. (2010). Do Expectations Matter? The Great Moderation Revisited. *American Economic Journal* 2 (3): 183-205.

Canova, F and Forero, F.J. (2015). Estimating Overidentified, Nonrecursive, Time-Varying Coefficients Structural Vector Autoregressions. Quantitative Economics 6 (2): 359-384.

Carlson, M. and Burcu D. (2016). The Tools and Transmission of Federal Reserve Monetary Policy in the 1920s. FEDS Notes. *Washington: Board of Governors of the Federal Reserve System,* https://doi.org/10.17016/2380-7172.1871.

Cecchetti, S.G. (1992). Prices during the Great Depression: Was the Deflation of 1930-1932 Really Unanticipated? *American Economic Review* 92, 141-156.

Christiano, L. J., Eichenbaum, M., Evans, C. L. (1998). Monetary Policy Shocks: What have We Learned and to What End? In: *Taylor, J.B. and Woodford, M. (Eds.), Hanbook of Macroeconomics. Elsevier, Amsterdam*, 65-148.

Clarida, R., Galí, J., and Gertler, M. (2000). Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory. *Quarterly Journal of Economics* 115 (1): 147-180.

Clouse, J. A. (1994). Recent Developments in Discount Window Policy. *Federal Reserve Bulleting*, November, 965-977.

Cogley, T. and Sargent, T. J. (2001). Evolving Post-World War II U.S. Inflation Dynamics. *NBER Macroeconomics Annual* 16.

---------- (2005). Drifts and Volatilities: Monetary Policies and Outcomes in the Post WWII US. *Review of Economic Dynamics* 8, 262-302.

Eichengreen, B. (1990). International Monetary Instability Between the Wars: Structural Flaws or Misguided Policies? Published as: The Evolution of the International Monetary System, edited by Suzuki Y., Miyake J. and Okabe, M. University of Tokyo Press, 71-116.

Favero, C. A. and Rovelli, R. (2003). Macroeconomic Stability and the Preferences of the Fed: A Formal Analysis, 1961-98. *Journal of Money*, *Credit and Banking* 35 (4): 545-556.

Fernández-Villaverde, J., Rubio-Ramírez, J. F., Sargent, T. J. and Watson, M. W. (2007). ABCs (and Ds) of Understanding VARs. *American Economic Review*, 97 (3): 1021-1026.

Fforde, J. S. (1954). The Federal Reserve System 1945-1949. *Oxford University Press*.

Forni, M., Gambetti, L., and Sala, L. (2014). No News in Business Cycles. *The Economic Journal* 124, 1168-1191.

Forni, M. and Gambetti, L. (2010). The Dynamic Effects of Monetary Policy: A Structural Factor Model Approach. *Journal of Monetary Economics* 57 (2): 203-216.

…… (2014). Sufficient Information in Structural VARs. *Journal of Monetary Economics* 66, 124-136.

Friedman, M., and Schwartz, A.J. (1963). A Monetary History of the United States 1867 to 1960, *Princeton University Press*.

Galí, J. and Gambetti, L. (2009). On the Sources of the Great Moderation. *American Economic Journal*: Macroeconomics 1 (1): 26-57.

Giannone, D., Lenza, M. and Reichlin, L. (2008). Explaining the Great Moderation: It is not the Shocks. *Journal of the European Economic Association* 6, 621–633.

Goodfriend, M. (1993). Interest Rate Policy and the Inflation Scare Problem: 1979-1992. *FRB Richmond Economic Quarterly* 79 (1): 1-23.

Geweke, J. (1992). Evaluating the Accuracy of Sampling-Based Approaches to the Calculation of Posterior Moments. *Bayesian Statistics,* Oxford University Press 4.

Hamilton, J.D. (1987). Monetary factors in the Great Depression. *Journal of Monetary Economics* 19, 145-170.

Hanson, M. S. (2006). Varying Monetary Policy Regimes: A Vector Autoregressive Investigation. *Journal of Economics and Business* 58, 407-427.

Hetzel, R.L. (1985). The Rules Versus Discretion Debate over Monetary Policy in the 1920s. *Federal Reserve Bank of Richmond Economic Quarterly* 71, 3-14.

Hetzel, R. L. and Leach, R. F. (2001). The Treasury-Fed Accord: A New Narrative Account. *Federal Reserve Bank of Richmond Economic Quarterly* 87.

Hetzel, R. L. (2008). The Monetary Policy of the Federal Reserve: A History.Cambridge University Press.

Kasriel, P. L. and Merris, R.C. (1982). Reserve Targeting and Discount Policy. *Economic Perspectives*, 6 (3).

Koch, C. (2015). Deposit Interest Rate Ceilings as Credit Supply Shifters: Bank Level Evidence on the Effect of Regulation Q. *Journal of Banking and Finance* 61, 316-326.

Leeper, E. M. (1997). Narrative and VAR Approaches to Monetary Policy: Common Identification Problems. *Journal of Monetary Economics* 40 (3): 641–657.

Leeper, E. M., Walker, T. B., and Yang, S. S. (2013). Fiscal Foresight and Information Flows. *Econometrica, Econometric Society*, 81 (3): 1115-1145.

Lippi, M., and Reichlin, L. (1994). "VAR Analysis, Non-fundamental Representations, Blashke Matrices. *Journal of Econometrics* 63 (1): 307-325.

Mayer, T. (1999). Monetary Policy and the Great Inflation in the United States: the Federal Reserve and the Failure of Macroeconomic Policy, 1965-1979. *Edward Elgar Publishing*.

McCallum, B.T. (1990). Could a Monetary Base Rule have Prevented the Great Depression? *Journal of Monetary Economics* 26 (1): 3-26.

McConnell, M. M. and Perez-Quiros, G. (2000). Output Fluctuations in the United States: What Has Changed since the Early 1980's. *American Economic Review* 90 (5): 1464-1476.

Meltzer A.H. (2003). A History of the Federal Reserve: 1913-1951. Volume I. The University of Chicago Press.

---------- (2009a). A history of the Federal Reserve: 1951-1969. Volume II.1. The University of Chicago Press.

---------- (2009b). A history of the Federal Reserve: 1970-1986. Volume II.1. The University of Chicago Press.

Miron, J. A. (1988). The Founding of the Fed and the Destabilization of the Post-1914 Economy. *NBER Working Paper* 2701.

Moore, C. H. (1990). The Federal Reserve System: A History of the 75 first years. McFarland & Co.

Moreno, A. (2004). Reaching Inflation Stability. *Journal of Money, Credit and Banking*, 36(4): 801-825.

Orphanides, A. (2004a). Monetary Policy in Deflation: the Liquidity Trap in History and Practice. *North American Journal of Economics and Finance* 15, 101-124.

---------- (2004b). Monetary Policy Rules, Macroeconomic Stability, and Inflation: A view from the Trenches. *Journal of Money, Credit and Banking* 36, 151-175.

---------- (2003). Historical Monetary Policy analysis and the Taylor Rule. *Journal of Monetary Economics* 50, 983-1022.

Pearce, D.K. (1993). Discount Window Borrowing and Federal Reserve Operating Regimes. *Economic Inquiry* 31, 564-579.

Peristani, S. (1991). The Model Structure of Discount Window Borrowing. *Journal of Money, Credit and Banking 23 (1): 13-34.*

Pivetta, F. and Reis, R. (2007). The Persistence of Inflation in the United States. *Journal of Economic Dynamics and Control* 31 (4): 1326-1358.

Primiceri, G. E. (2005). Time Varying Structural Vector Autoregressions and Monetary Policy. *Review of Economic Studies* 72, 821-852.

Raftery, A.E. and Lewis, S.M. (1992a). Comment: One Long Run with Diagnostics: Implementation Strategies for Markov Chain Monte Carlo. *Statistical Science*, 7 (4), 493-497.

…… (1992b). The Number of Iterations, Convergence Diagnostic and Generic Metropolis Algorithm. In: *Gilks, W.R. and Spiegelhalter, D.J (Eds), Practical Markov Chain Monte Carlo,* 115-130.

Ramey, V.A. (2011). Identifying Government Spending Shocks: It's all in the Timing. *The Quarterly Journal of Economics*, Oxford University Press 126 (1): 1-50.

Ritschl, A. and Woitek, U. (2000). Did Monetary Forces Cause the Great Depression? A Bayesian VAR analysis for the US economy. *Discussion Paper No. 2547*, CEPR.

Romer, C. D. and Romer, D. H. (1989). Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz. *NBER Macroeconomics Annual* 4.

Romer, C. D. and Romer, D. H. (2004). A New Measure Of Monetary Shocks: Derivation And Implications. *American Economic Review* 94, 1055-1084.

Rudebusch, G. D. (1998). Do Measures of Monetary Policy in a VAR Make Sense? *International Economic Review* 39 (4): 907-931. Symposium on Forecasting and Empirical Methods in Macroeconomics and Finance

Shapiro, M.D. (1994). Federal Reserve Policy: Cause and Effect. *Monetary Policy, Mankiw.*

Sims, A. C. (1998). Comment on Glenn Rudebusch's "Do Measures of Monetary Policy in a VAR Make Sense? *International Economic Review* 39 (4): 933-941, Symposium on Forecasting and Empirical Methods in Macroeconomicsand Finance.

Sims, A. C. and Zha, T. (2006). Were There Regime Switches in U.S. Monetary Policy? *American Economic Review* 96 (1): 54-81.

Strongin, S. (1995). The Identification of Monetary Policy Disturbances. Explaining the liquidity puzzle. *Journal of Monetary Economics* 35, 463-497.

Stock, J. H. and Watson, M. W. (2003). Has the Business Cycle Changed and Why? *NBER Macroeconomics Annual* 2002, 17.

Temin, P. (1976). Did Monetary Forces Cause the Great Depression? *New York: Norton.*

Toma, M. (1989). The Policy Effectiveness of Open Market Operations in the 1920s. *Explorations in Economic History* 19, 99-116.

---------- (1997). Competition and Monopoly in the Federal Reserve System, 1914-1951. *Cambridge University Press*.

Triffin, R. (1964). The Evolution of the International Monetary System: Historical Reappraisal and Future Perspectives. *Princeton Studies in International Finance* 12.

Uhlig, H. (2005). What are the Effects of Monetary Policy on Output? Results from an agnostic identification procedure. *Journal of Monetary Economics* 52, 381-419.

Velde, F. R. (2004). Poor Hand or Poor Policy? The Rise and Fall of Inflation in the U.S. Federal Reserve Bank of Chicago. *Economic Perspectives* 28 (1): 34-51.

Wheelock, D.C. (1989). The Strategy, Effectiveness and Consistency of Federal Reserve Monetary Policy 1924-1933. *Explorations in Economic History* 26:453- 476.

Wheelock, D.C (1990). Member Bank Borrowing and the Fed's Contractionary Monetary Policy during the Great Depression. *Journal of Money, Credit and Banking* 22 (4): 409-426.

Wheelock, D.C. (1991). The Strategy and Consistency of Federal Reserve Monetary Policy 1924-1933. Cambridge University Press.

Wicker, E. (1965). Federal Reserve Monetary Policy, 1922-33: A Reinterpretation. *Journal of Political Economy* 73, 325-34

Appendix A - Impulse response functions

In this section the reader can find the remaining impulses responses from section 5. Even though they are not essential to understand the results obtained, they offer some details about the mechanisms working between instruments and final targets.

A.1 - Interwar period

Paying attention to an M1 shock (Figure A.4.7), the response of the inflation shows no clear pattern. Between 1925 and 1927 an increase in the money supply have a mostly positive response, although only after one month. During the period when gold inflows were accelerating but the Fed was offsetting them (1927-1929), increases in M1 would have increased the inflation more than in the rest of the period given the levels of deflation. From 1930 to 1933, the response is mostly negative, except for a delayed positive response between the second half of 1931 and first half of 1932. The stagnation of business, bank failures, the increase in currency and reserves holdings, and the gold outflow, could have contributed to this mostly negative response, without forgetting the negative spread. The delayed positive response between 1931 and 1932 could correspond to gold inflows and the pressures that the Fed received to purchase in the open market. Since 1933 the response of the inflation is initially negative and becomes slightly positive after three-five months. Again, accumulation of excess reserves, increases in reserve requirements and the negative spread could have contributed.

A shock to M1 (Figure A.4.8) shows mostly a negative response of the IPI between 1928-1929, years of deflation and sterilization of gold inflow. From 1925 to 1927, the response is mostly positive, except for the initial negative response in 1925 and part of 1926, again, periods of deflation or low inflation. Thus, deflation could have restrained output growth. Contrary to those periods of deflation, the response is positive from 1930-1932, (brief open market purchases and gold inflows for those years) becoming negative in the second half of 1932 and having a negative peak in 1933, likely due to banking failures. The negative response continues until the end of 1935, slightly after the devaluation and the purchase of silver and gold. It turns positive since 1936, when the Treasury desterilized the gold flows from previous years.

Regarding the impulse responses of M1, a shock to both, the discount rate (Figure A.4.9) and to C-D (Figure A.4.11) has a negative response, although for the last

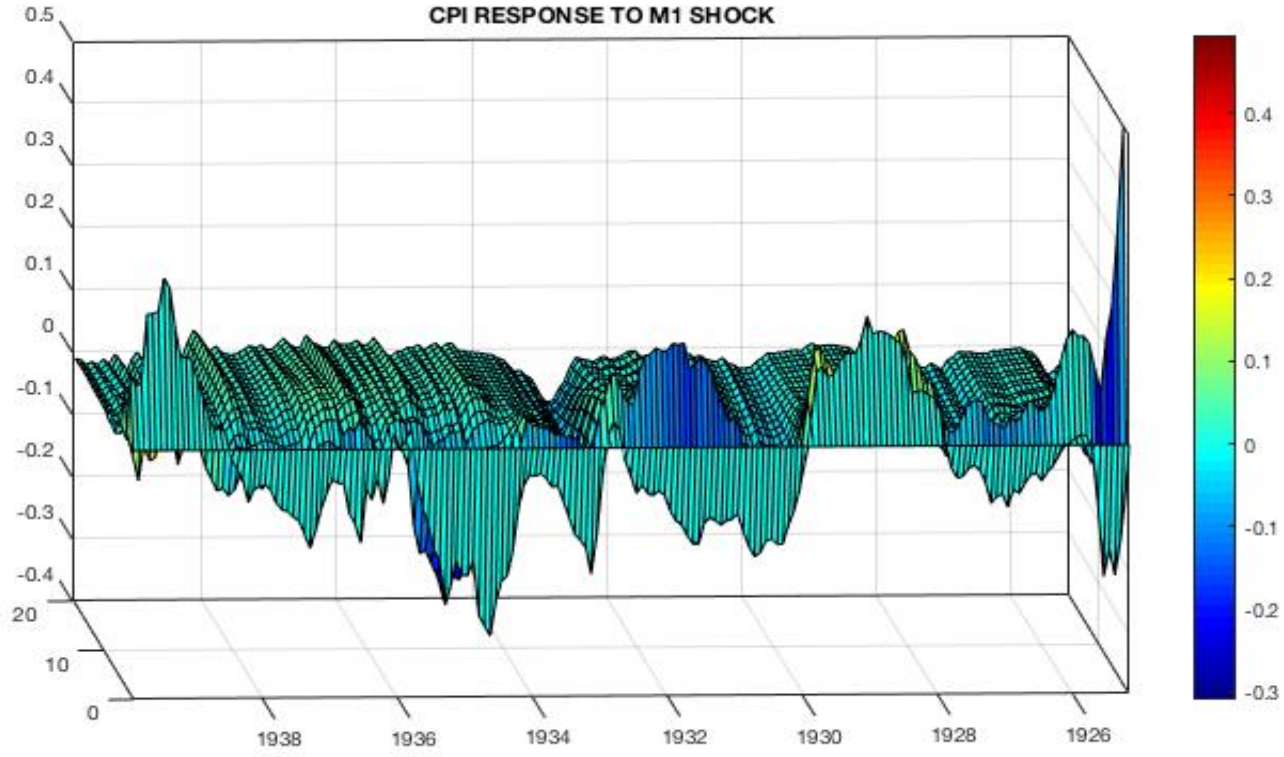


Figure A.4.7 - CPI inflation impulse response to an M1 shock. Note: Posterior means.

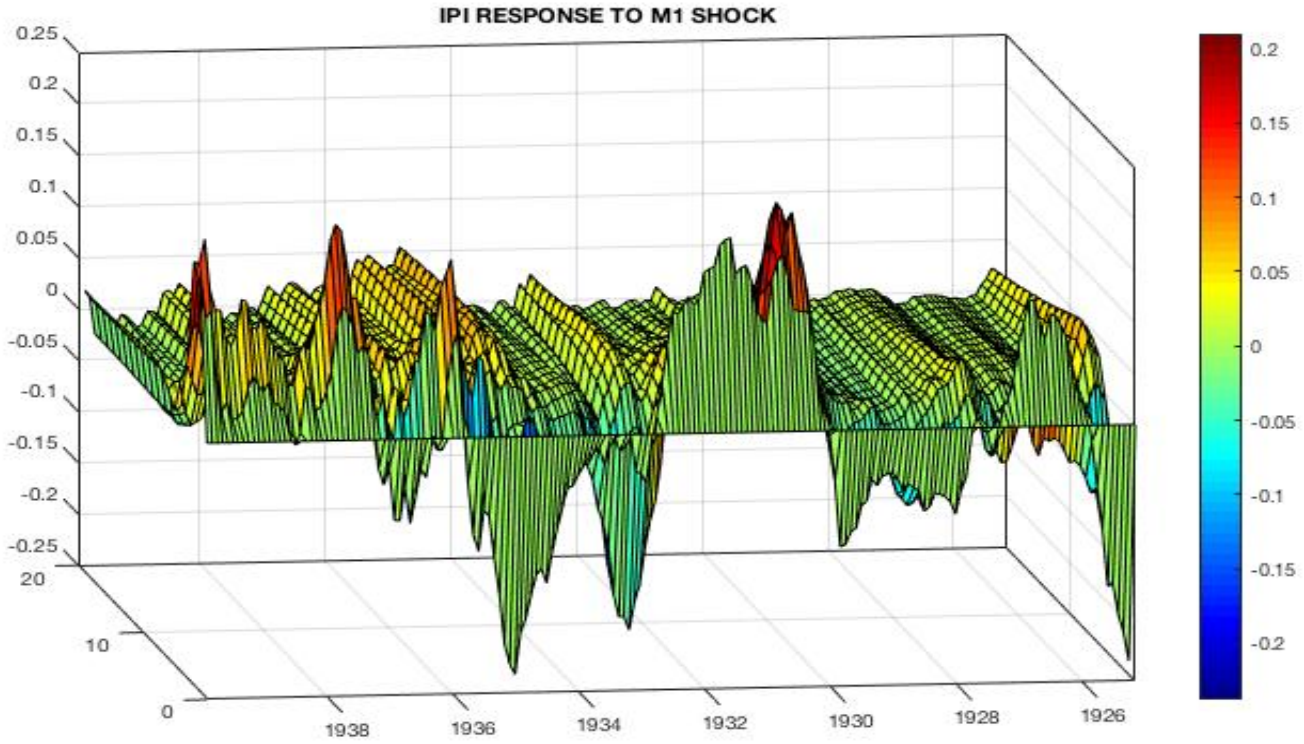


Figure A.4.8 - IPI impulse response to an M1 shock. Note: Posterior means.

figure, it becomes positive after two months and it is not significant (Figure 5.3). When the shock is to OMO (Figure A.4.10) the response is positive as expected, but not significant (Figure 5.2). There is a positive peak in 1929 belonging to the moment when the Fed perceived indications of a recession. Accordingly, the Fed purchased in the open market, the money supply increased, but it was not enough (as observed in 1.4.2) to increase inflation. Only the discount rate has a significant impact on M1 for virtually the entire period (Figure 5.1), except for 1930-1932 and 1937, corresponding to the sterilization of gold and deflation periods. For the other cases, the responses are significant mostly after the second month and last beyond the impulse response horizon. The response of C-D to a discount rate shock (Figure A.4.12) has a positive response that becomes negative or zero after approximately nine or ten months, from 1925 to the end of 1929. This is the period when the discount rate was below the call loans rate. From 1930 to the end of 1937 the initial response is negative, becoming positive after approximately six to eight months between 1930 and 1934, and one to two months from 1934 to the end of 1937. This happens while the discount rate is above the call loans rate. After 1937, when both rates were at the same level, the response is negative. Thus, the increase in the discount rate led to a relative higher increase in the call loan rate in the first part of the sample, and this pattern reversed since then, when the Fed and the Treasury tried to keep short-term rates low to finance government spending. The response of C-D to an OMO shock (Figure A.4.13) is negative for the entire period, although for 1928 the response becomes positive after two to four months. Therefore, purchases in the open market decreased short-term rates and consequently, the spread. Last, the response of OMO to a discount rate shock (Figure A.4.14) is negative for the whole period, as it would be expected.

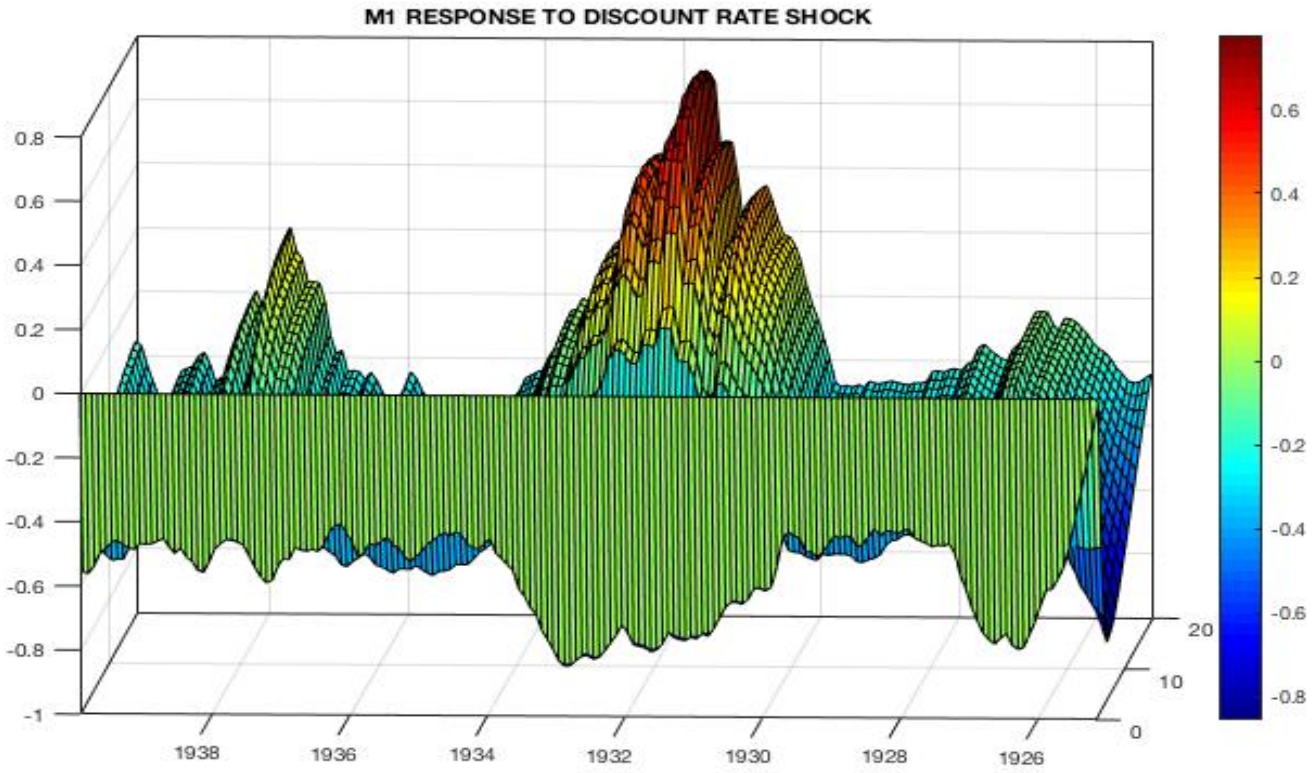


Figure A.4.9 – M1 impulse response to a discount rate shock. Note: Posterior means.

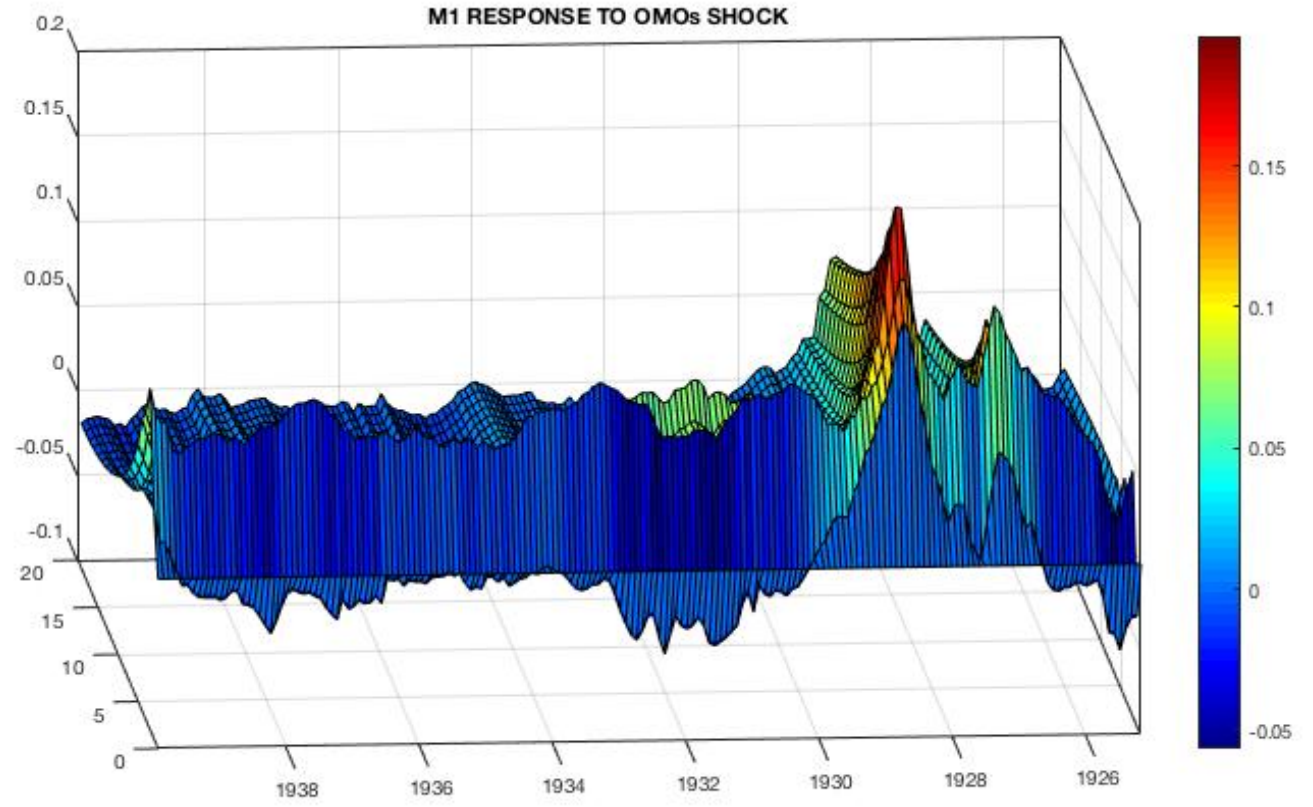


Figure A.4.10 – M1 impulse response to an OMO shock. Note: Posterior means.

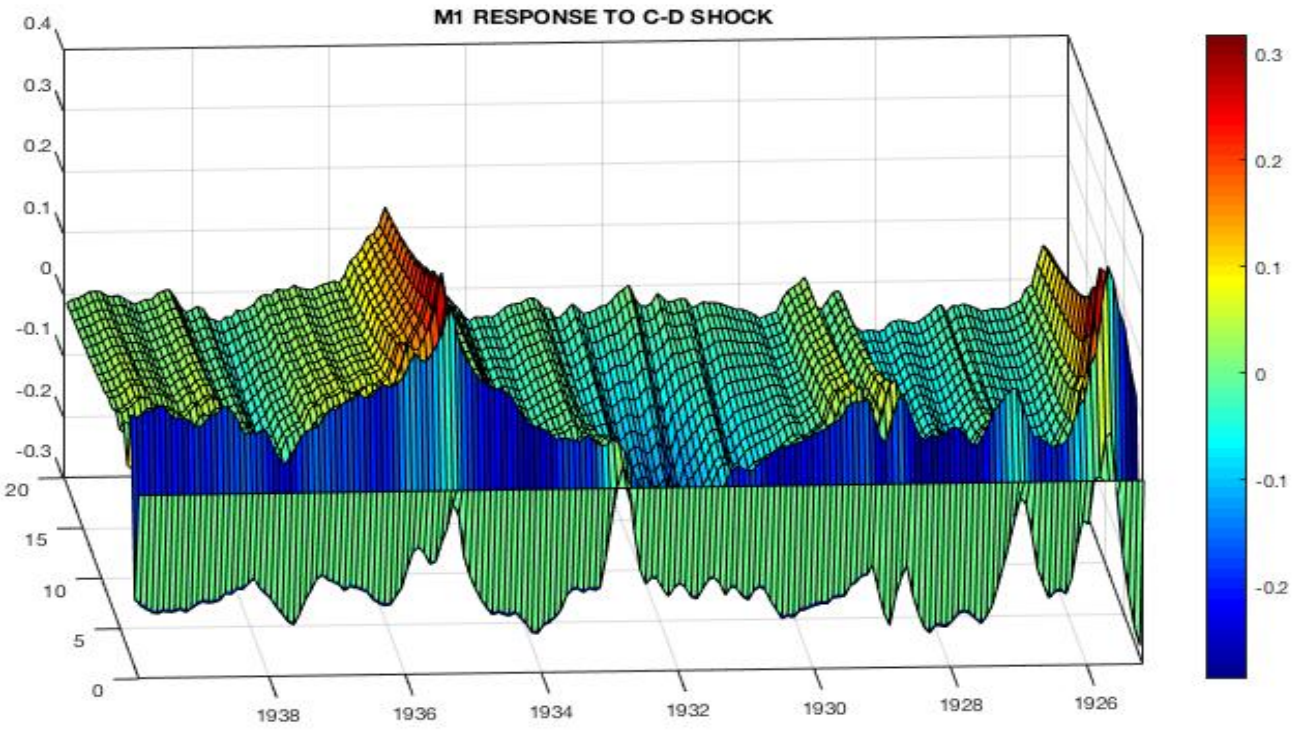


Figure A.4.11 – M1 impulse response to a C-D shock. Note: Posterior means.

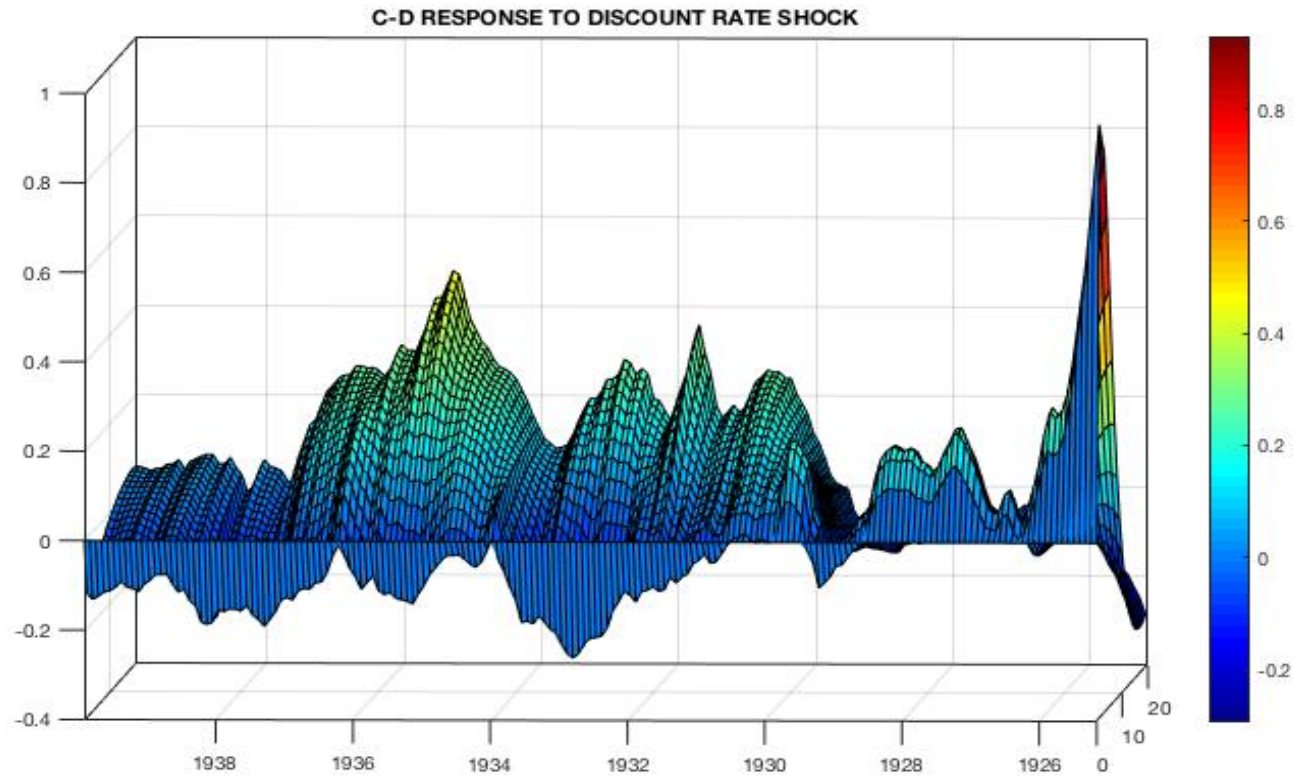


Figure A.4.12 – C-D impulse response to a discount rate shock. Note: Posterior means.

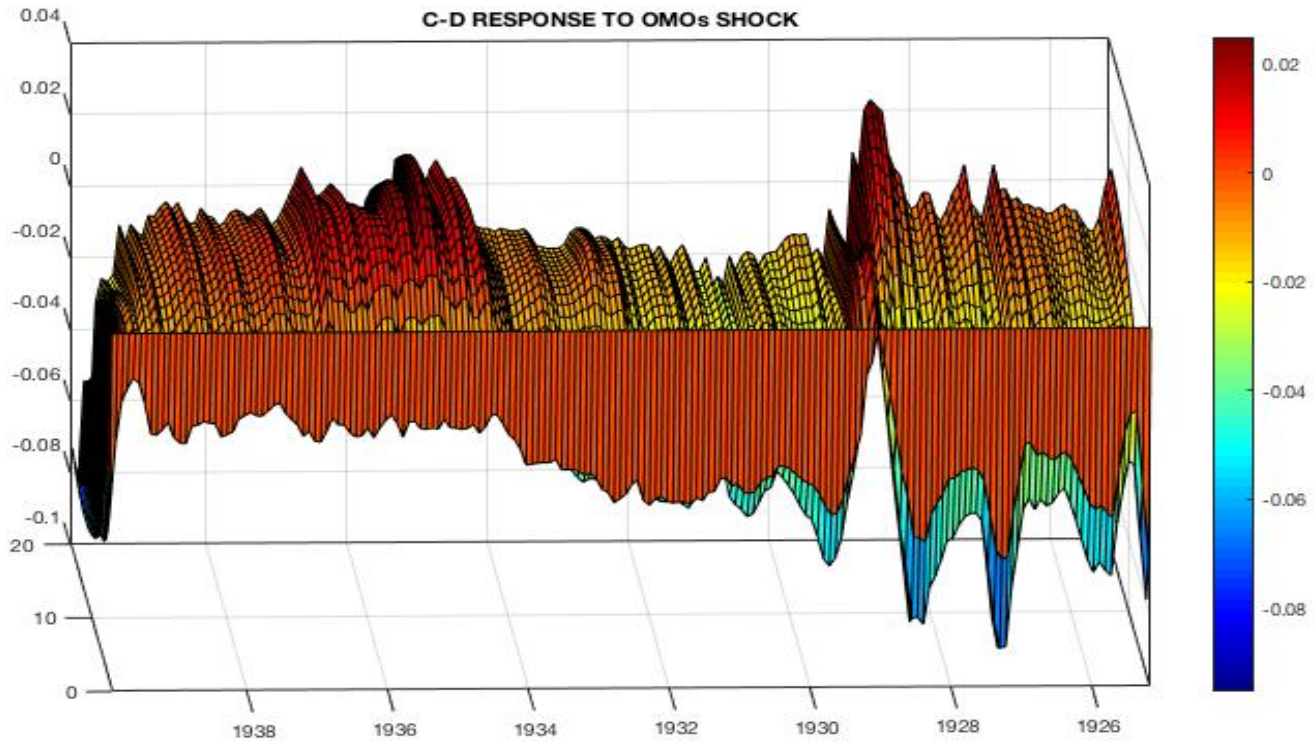


Figure A.4.13 – C-D impulse response to an OMO shock. Note: Posterior means.

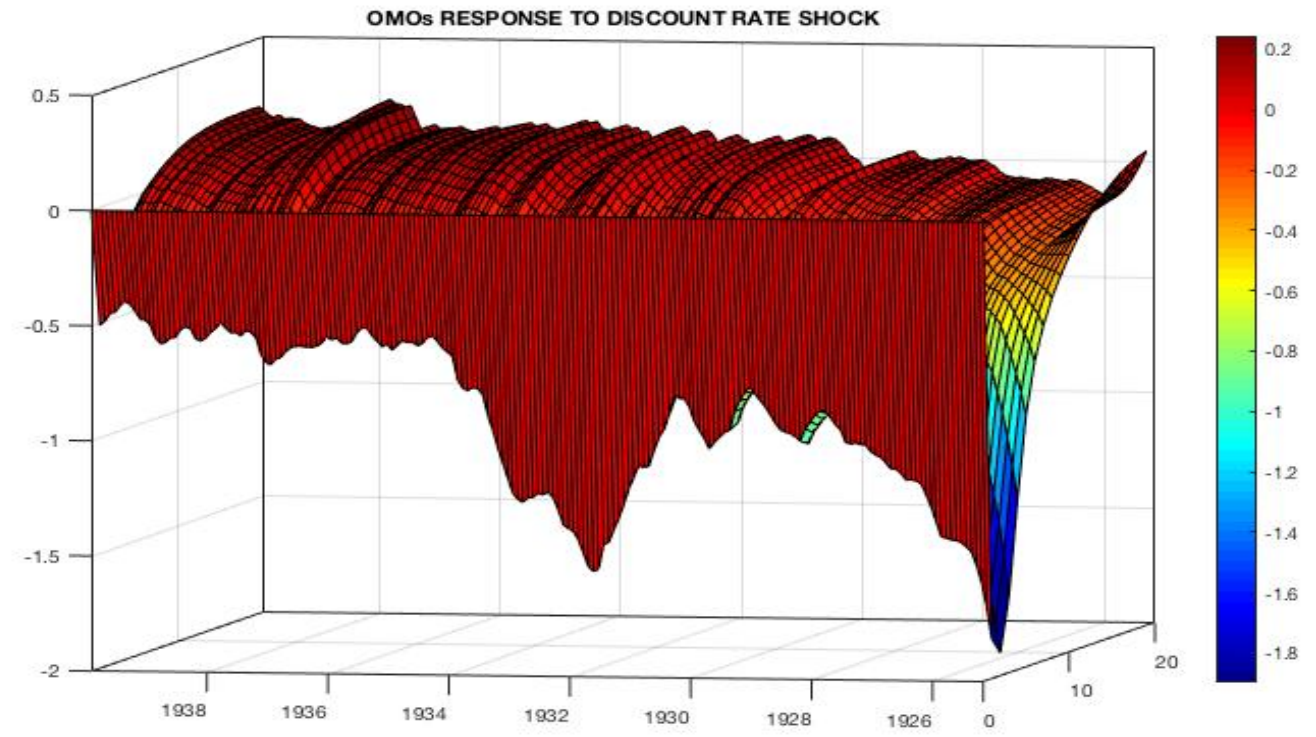


Figure A.4.14 – OMO impulse response to a discount rate shock. Note: Posterior means.

A.2 - 1958-2007

The response of M1 to a F-D shock (Figure A.7.7) is very similar to Figure A.7.1 Thus, for those years with positive spread banks increased borrowing and lending, increasing M1. After 1986, as already commented, there was another large spread. However, as in Figure 7.1, now the response is not as positive as in the other cases[18]. From 1970 to 1990 the positive response is significant (Figure 8.1). After 1995, when the spread was positive again, the response becomes more positive. Surprisingly, after 2003, although the discount rate was above the federal funds rate, and even above inflation after 2004, the response of M1 becomes increasingly positive. This time, however, it is not significant (Figure 8.1). The response of M1 to an OMO shock (Figure A.7.8) has a positive effect for the entire period but is not significant (Figure 8.2). The positive peaks occur when the federal funds rate and discount rate are at similar levels after their local maximum. This could indicate that when the Fed observed low borrowing at the discount window, possibly a signal of low credit growth, it purchased more in the open market to boost lending with lower rates.

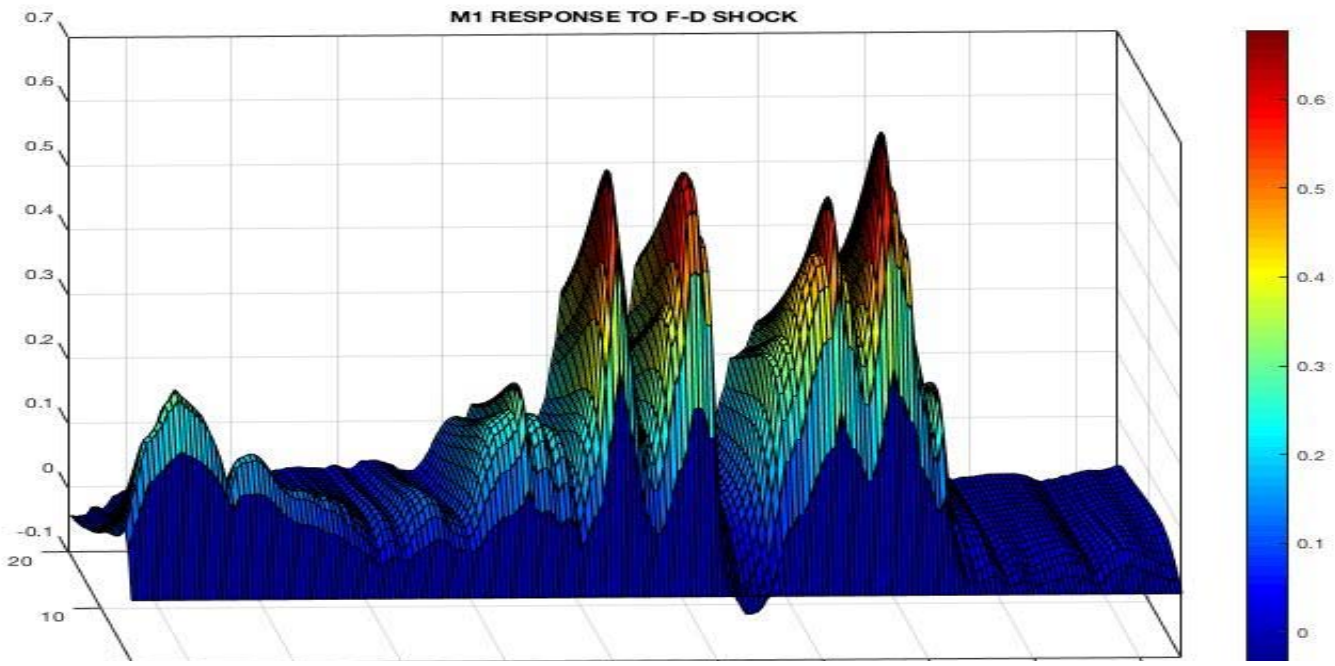


Figure A.7.7 – M1 impulse response to a F-D shock. Note: Posterior means.

This hypothesis is reinforced by the response of F-D to an OMO shock (Figure A.7.9), where the positive peaks coincide with periods of a small (positive or negative) or zero spread

[18] Using K-P algorithm and two lags, the impulse response shows even an initially negative response after 1985, although it turns positive shortly after.

between rates, what occurs just after those rates have been in local maximum[19]. It seems that despite this pattern, the Fed extended its purchases a little more during the years of positive spread between 1969-1971. In 1990 the almost-zero or zero spread did not avoid Fed's purchases due to the recession. This is in line with Figure A.7.8, as after the 1980s is observed that despite having positive spreads in the periods 1986-1990 and 1994-2000, it seems that, likewise, the Fed purchased significantly in the open market, as the response of M1 to an OMO shock is positive. This could be related to the decrease in borrowing after the 1980s. Figure A.7.10 confirms the results of Figure 7.3*,* as the response of M1 to a discount rate shock is positive for the entire period, pointing out that despite the increase in the discount rate, M1 still was raising because of the purchases in the open market and increases in borrowing given the positive spreads. Both figures share significance for almost the same periods (Figure 8.3). Analysing the inflation response to an M1 shock (Figure A.7.11), it is negative almost for the whole period, not being the expected result. The negative peaks (except for that between 1960-1962) occur some time after the maximums of the federal funds rate. Hence, it seems to be capturing the following: when there were maximum in the federal funds rate (Figure 1), which normally coincided with large spreads, it was when M1 was in its highest levels. Subsequently, rates were lowered, because the economy could not endure those high rates and lending decreased. However, the higher supply of money was already in the market and it was a matter of time that prices increased. When it happened, the money supply had already begun to decrease (this is what the model is capturing here), as positive spreads had disappeared, together with the decline in borrowing and loans. Thus, the relationship M1-CPI may need more lags to capture the right effect. Beyond that possible explanation, the behavior changes after mid-1998. Inflation responds positively initially, although after two quarters, it goes to zero or slightly negative.

[19] Although this effect is not clear, as the model estimated with two lags show a negative response, OMO impact is more likely to be captured with one lag. Hence, I consider the results with 1 lag more reliable in this case.

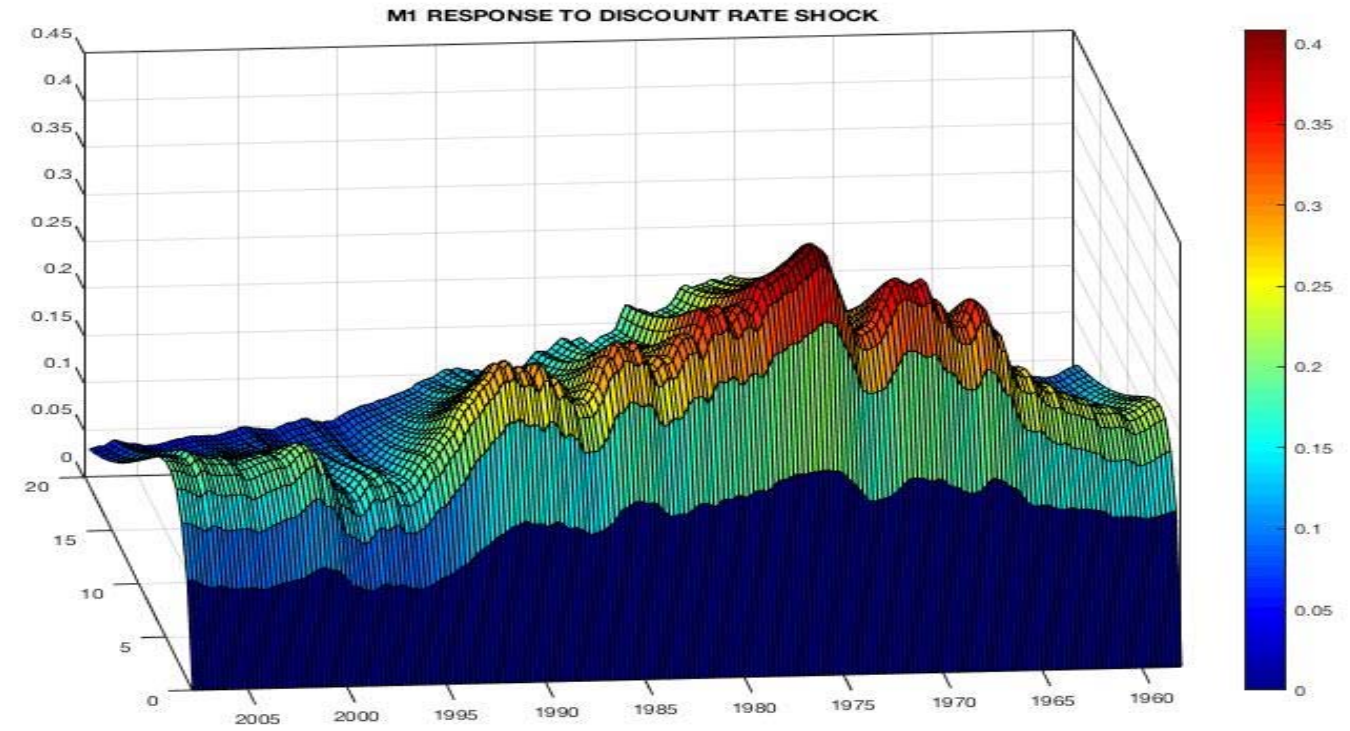


Figure A.7.10– M1 impulse response to a discount rate shock. Note: Posterior means.

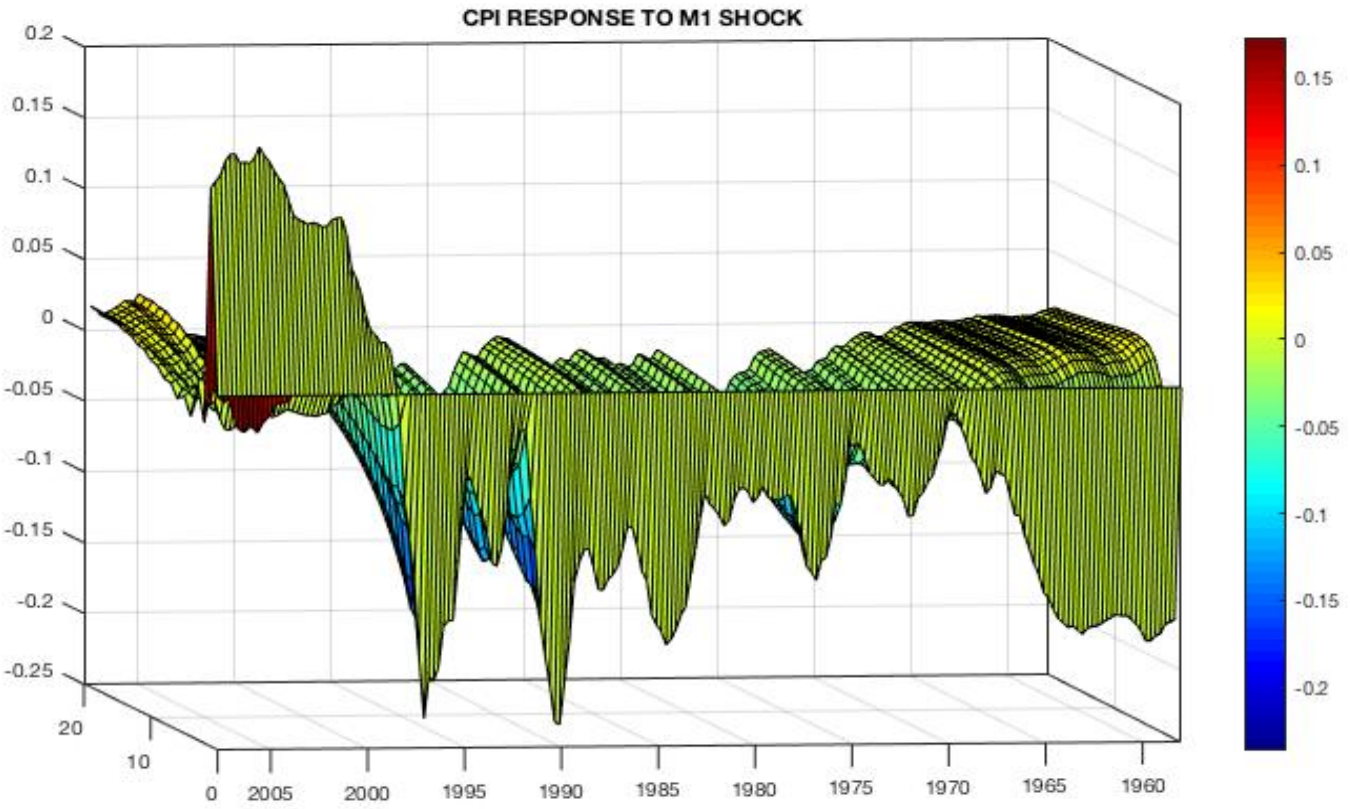


Figure A.7.11– CPI Inflation impulse response to an M1 shock. Note: Posterior means.

The response of the IPI to an M1 shock (Figure A.7.12) is initially negative, but after three or four quarters the response becomes positive, although this only starts to happen after approximately 1966. Subsequently, the initial negative response diminishes until disappearing at the end of 1987. After 1995, those initial or belated positive peaks occur when the spread was almost zero or negative. Again, the initial negative response could be a delayed effect, pointing out the necessity of more lags.

Last, the discount rate shock to F-D (Figure A.7.13) has a positive response for the whole period, showing that when the Fed increased the discount rate, the federal funds rate increased more in relation to the discount rate. The response of OMO to a discount rate (Figure A.7.14) shock is negative, as expected.

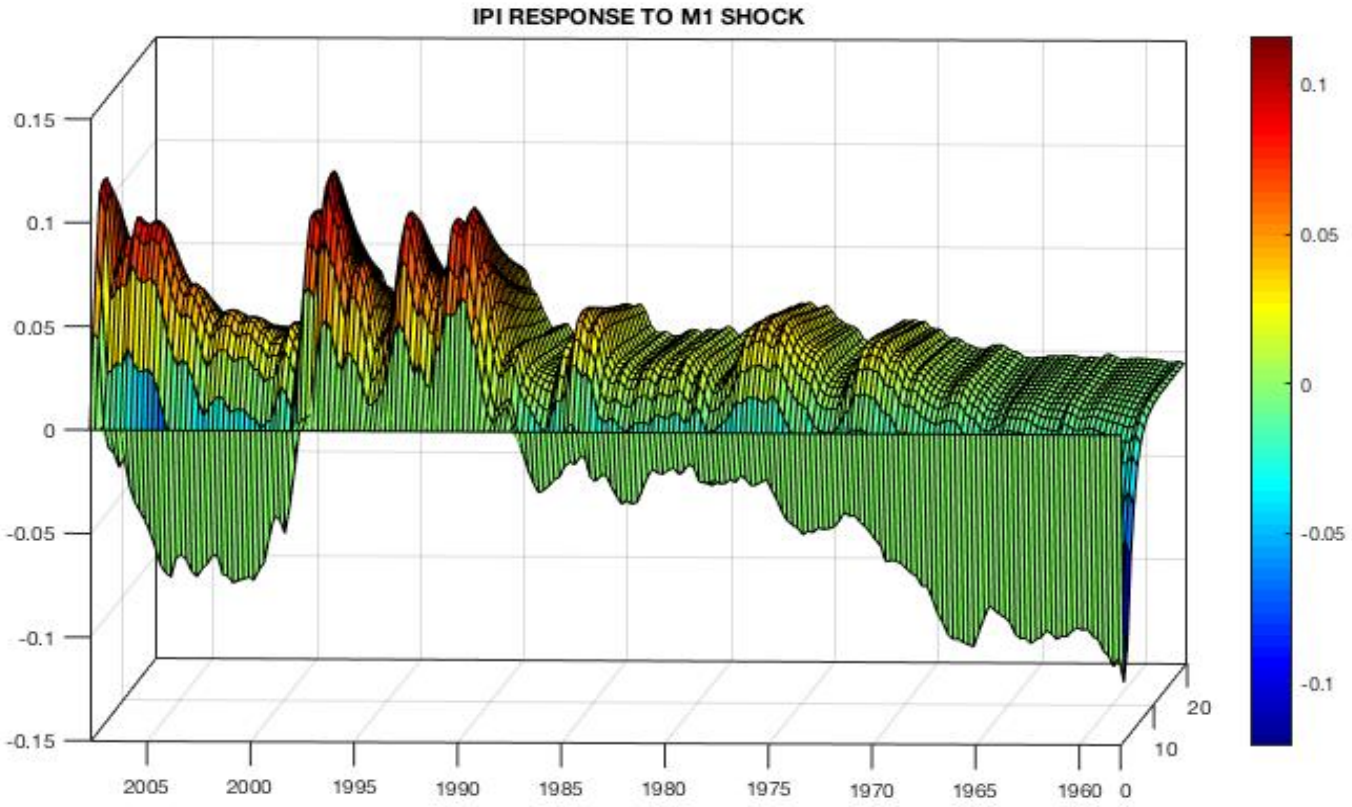


Figure A.7.12– IPI impulse response to an M1 shock. Note: Posterior means.

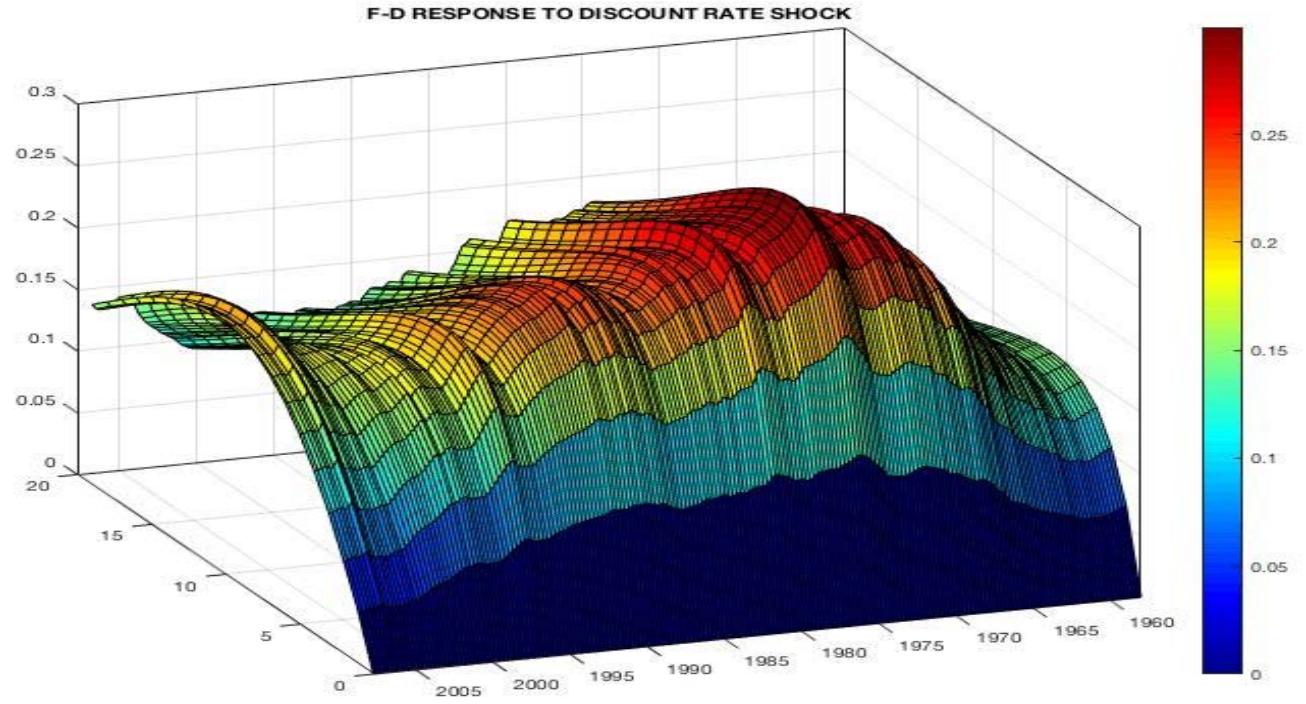


Figure A.7.13– F-D impulse response to a discount rate shock. Note: Posterior means.

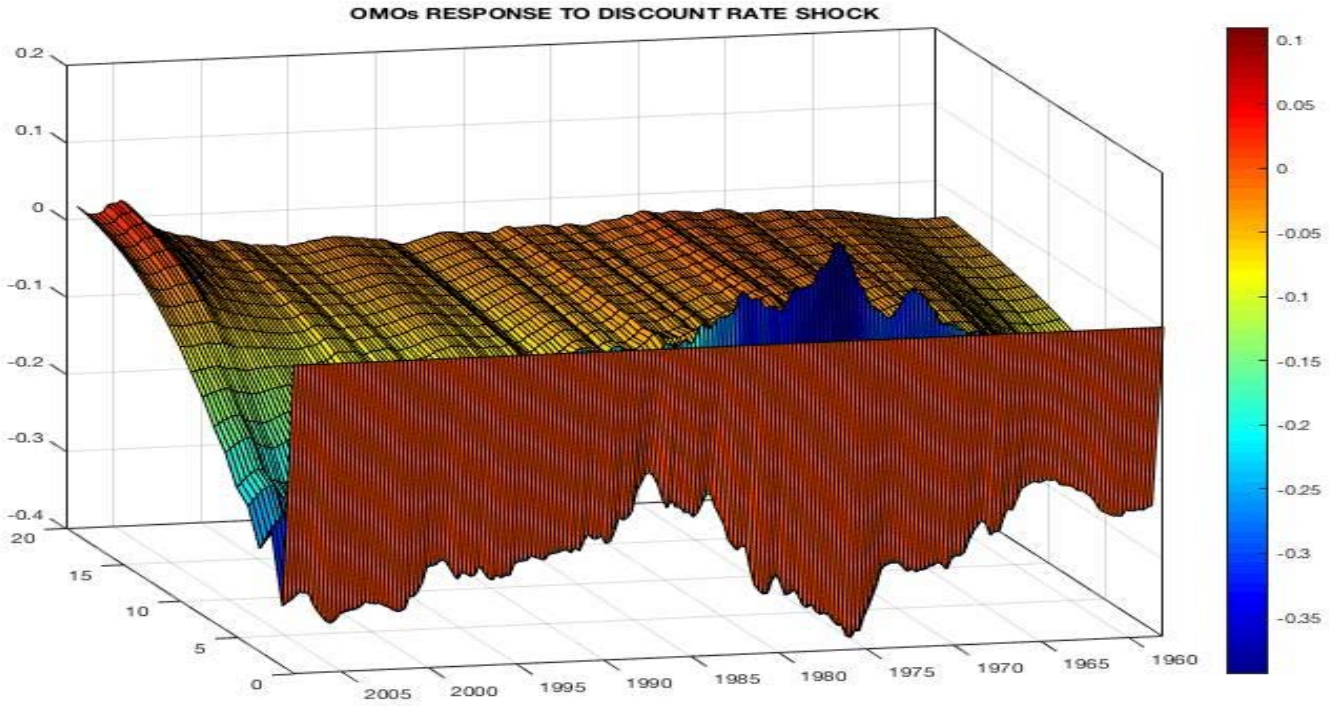


Figure A.7.14– OMO impulse response to a discount rate shock. Note: Posterior means.

Appendix B - Counterfactual methodology

The impulse response analysis for the second period shows that Fed's instruments, OMO and the discount rate, only have a regime switch around 1965. Moreover, the new variable F-D seems to present quite a dynamic behavior in relation to inflation, the IPI and M1. While during the 1970s the difference between the discount rate and the federal funds rate was not managed adequately as it increased inflation, around 1990, the sign of the response in Figure 7.1 is the opposite, negative. Hence, it seems that policies did not change and the banking sector modified its behavior. To support this hypothesis and discover whether different policies were applied, in this section I carry out a counterfactual analysis.

For that task, I have used the posterior mean of the average value of the parameters between 1995 and 1999, representing Greenspan's policies, and between 1971 and 1977 for Burns' policies. These values are used to simulate new ones for the rest of the parameters and for the other periods of the sample. Thus, the new values obtained for the parameters can be interpreted as those that would have been observed, had those policies been applied to the rest of the sample. In this case, unlike other works that draw the average of the posterior distribution from the monetary policy rule equation, meaning, the federal funds rate equation, here I draw the average values from the OMO, discount rate and F-D equations. In this type of analysis, the Lucas' critique arises as expectations and the private agents' behavior could have changed, had policies been modified at some point. However, given the Bayesian framework, in which policy is random and the model presents stochastic time variation of policy, the issue is hugely mitigated. Apart from that, I have included a new variable in the model, which is intended to capture inflation expectations. A new posterior distribution will be created for this variable every time that I introduce the new averaged values from Greenspan or Burns' policies. Thus, new expectations about inflations will be created for each counterfactual exercise. This new variable is inspired by Goodfriend (1993, pp.5-6), where he explained that the long-term yields should be a sum of the short-term rates with a variation, perhaps between two or three percentage points, plus the expected inflation. Thus, when the long-term rates increase more than the short-term rates, it is because the inflation expectations are higher. Consequently, the variable for the inflation expectations is built as follow: first, I take the difference of the short-term rate (3-months Treasury Bill rate) between period t and period t-1, and the same is done for the long-term rate (10-years government bonds yields). Once I have the difference of both rates, I use the difference of those two values. Then, the inflation expectations are captured when the long-term rate has increased or decreased more than the short-term rate. This variable

is located in the fourth position of the VAR, before M1 and after F-D, as during Volcker and Greenspan's mandate, they targeted long-term rates to control inflation. The results obtained are displayed in Figures B.10.1 (Greenspan's counterfactual) and B.10.2 (Burns' counterfactual). The CPI response to an F-D shock under Burns and Greenspan's policies are very similar. Under Burns' policies, the positive values are more positive than under Greenspan's policies, and for those periods when the response is negative, Burns' policies would have decreased inflation less. Apart from that, there is not significant difference between both figures and I cannot claim a change in Fed's policies after the 1980s or 1990s, despite Figure 7.1 shows a regime change for those years. For the rest of the impulse response analysis, figures are all almost identical for both counterfactuals. The same counterfactual was carried out with the 1960-1965 parameters, when Martin was the chairman of the Fed, but the results are alike. This casts doubts on the possible regime change observed for that period in Figures 7.2 and 7.3.

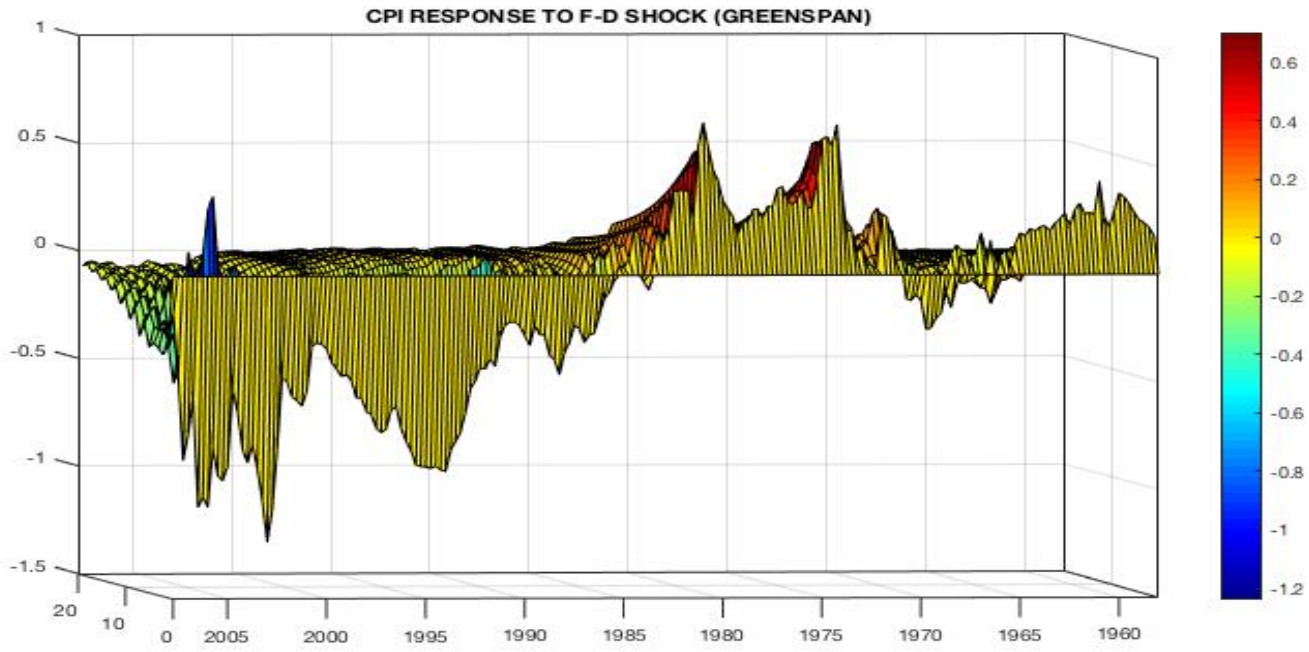


Figure B.10.1– CPI Inflation impulse response to a F-D shock (Greenspan). Note: Posterior means.

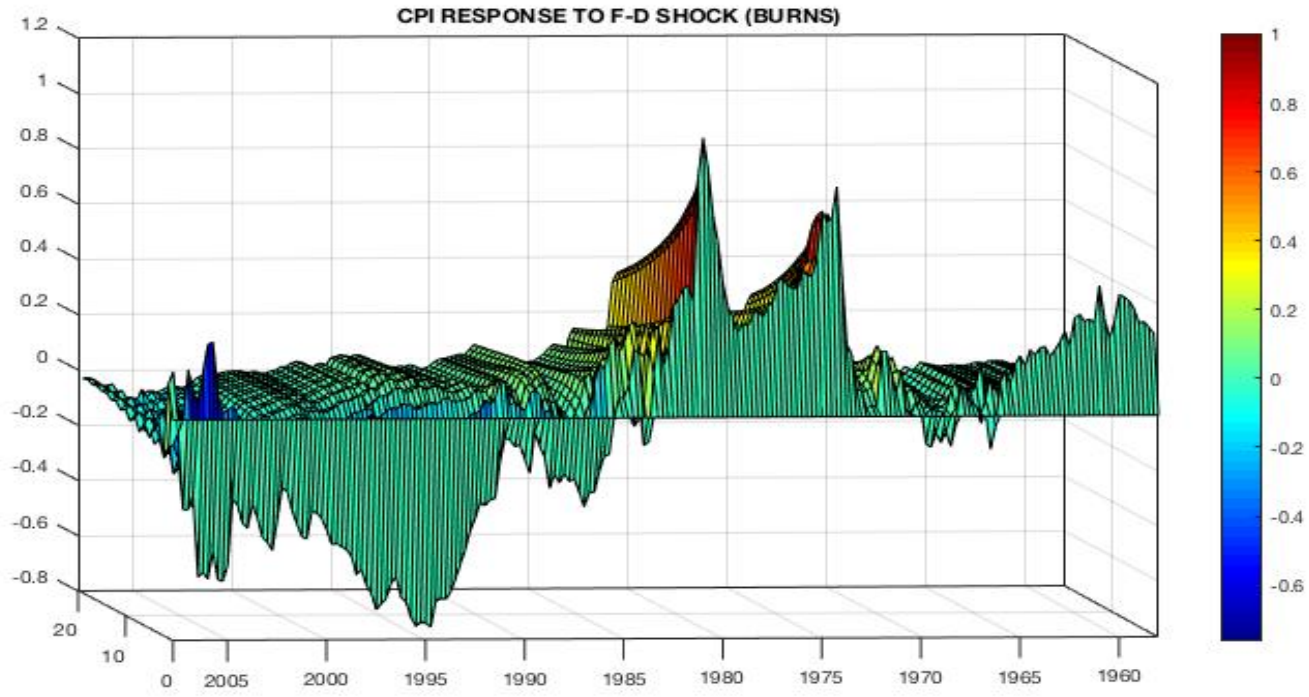


Figure B.10.2– CPI Inflation impulse response to a F-D shock (Burns). Note: Posterior means.

Appendix C – Convergence tests I

In this section, convergence of the Markov chain Monte Carlo algorithm is assessed for the baseline models. First, I present the inefficiency factor (IF), which is the inverse of the relative numerical efficiency (RNE) measure developed in Geweke (1992), for the posterior estimates of the parameters. RNE is a function of the serial correlation characteristics of the chain. The estimate (IF) is performed using a 4% tapered window for the estimation of the spectral density at frequency zero. Values below or around 20 can be considered as satisfactory. For space reasons results are not presented for the hyperparameters. Also, because they behave better than the parameters and all the values are below 20.

Second, to reassure that after the initial discarded sample and thinning of the chain the sample generated adequately represent the posterior distribution of interest, I calculate the I-statistic from Raftery and Lewis (1992b) that measures "the increase in the number of iterations due to dependence in the sequence" (Raftery and Lewis, 1992a). It is obtained from the formula $(M+N)/N_{min}$, where M is the initial number of iterations that should be discarded, N the number of iterations stored and required to achieve certain precision, and N_{min} the minimum number of iterations to reach convergence (Raftery and Lewis, 1992a). In this case, I apply it to the sample already "cleaned", so that I can evaluate if more iterations are needed, burned or it needs more "thinning". Those numbers are calculated for the quantile 0.025 of the posterior distribution of the parameters, estimated to within ± 0.005 with probability 0.95. That is, 95% intervals with posterior probability between 0.94 and 0.96. Values greater than 5 indicate dependence problems. Again, and for the same reasons as for the IF, the figures are presented only for the parameters. Figure C.11.1 and Figure C.11.2 display the results for the parameters B, α, and σ for the interwar period, and Figure C.12.1 and Figure C.12.2 for the second period.

In general, all the parameters reach convergence for the number of iterations indicated in section 4.1, as their values are below 20 for the IF estimate and below 5 for the I-statistic. Although the convergence of the Bs for the interwar period with K-P algorithm is not as good as for the other parameters, the IF estimate has a mean of 28.062, which can be considered as satisfactory. Regarding the I-statistic, only a few values are higher than 5.

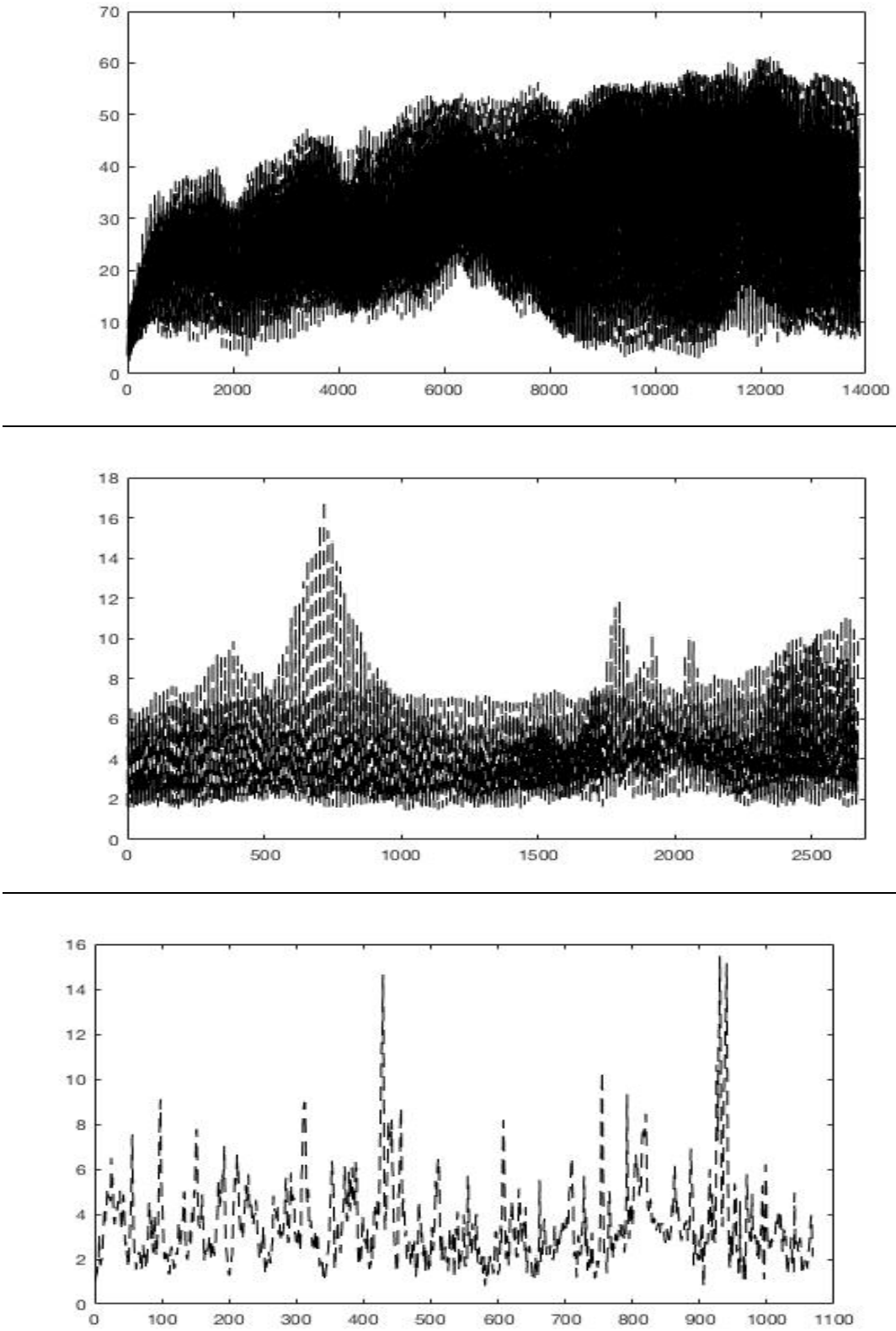


Figure C.11.1 – IF estimate for parameters B (Panel 1), α (Panel 2), and σ (Panel 3)

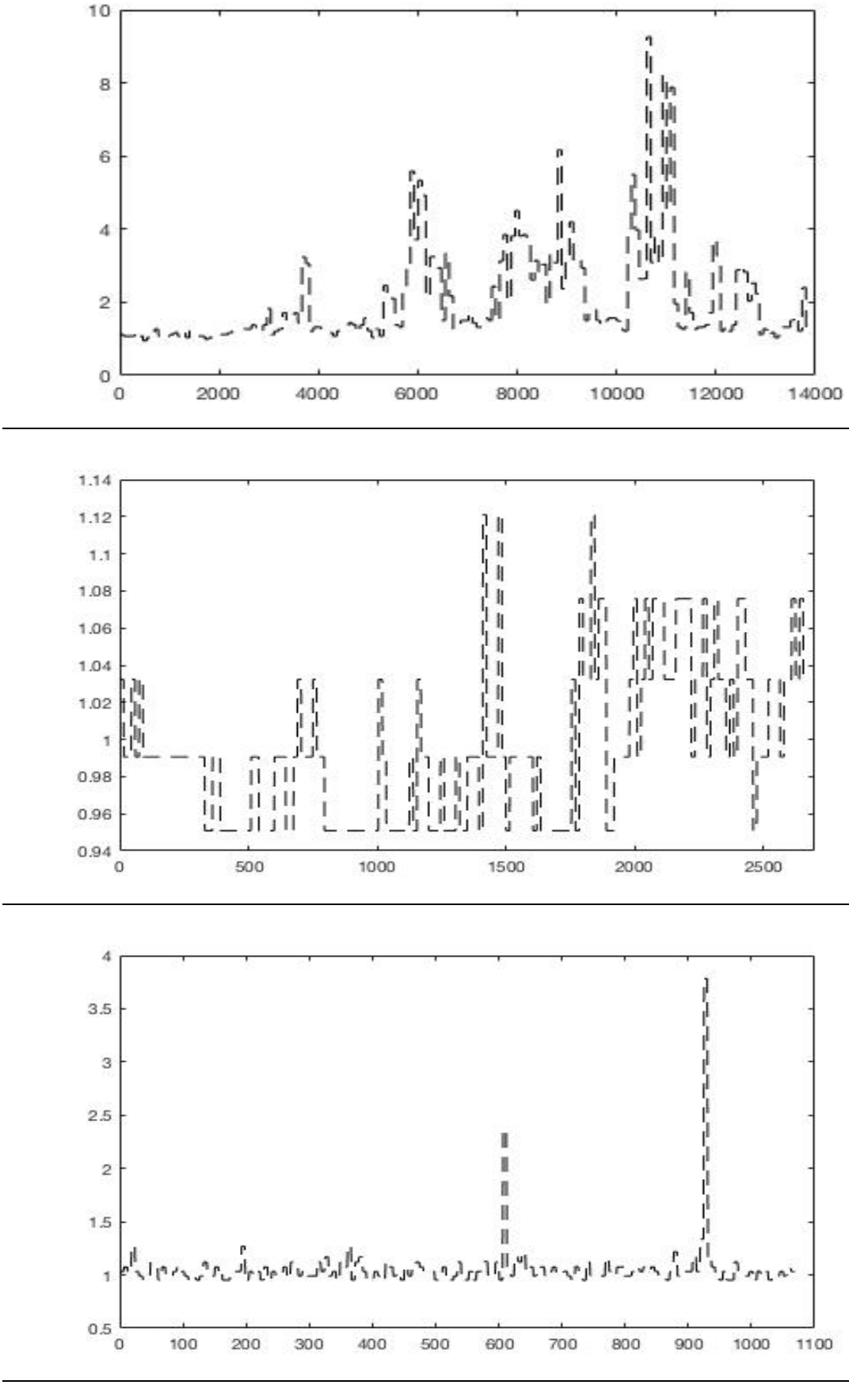
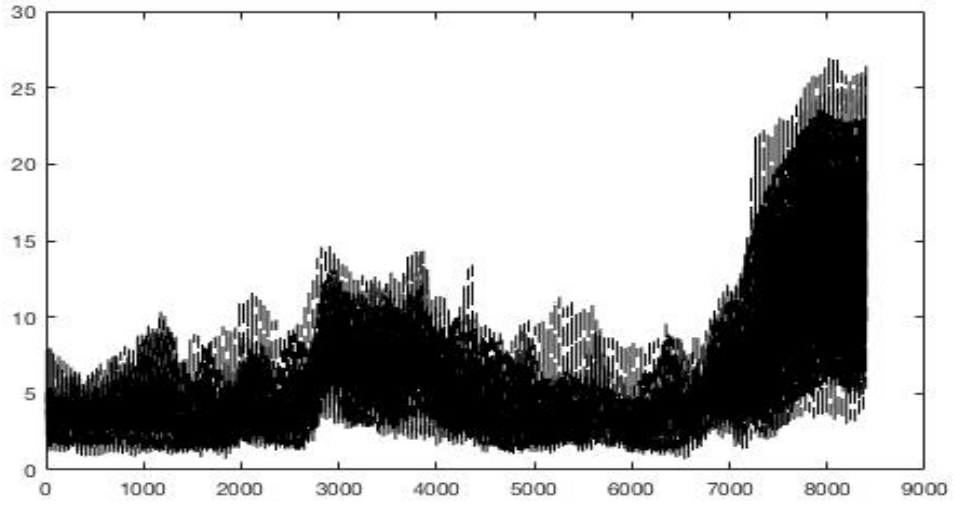
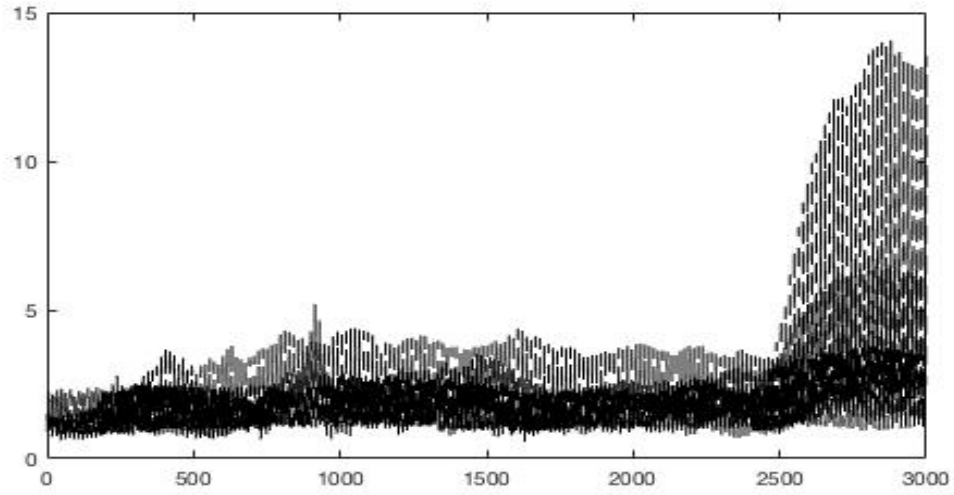


Figure C.11.2– I-statistic for parameters B (Panel 1), α (Panel 2), and σ (Panel 3)





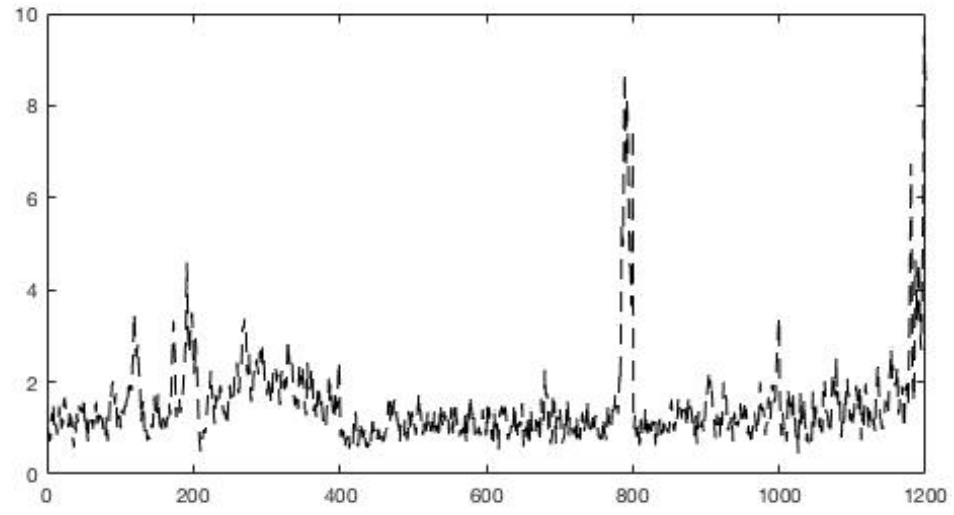
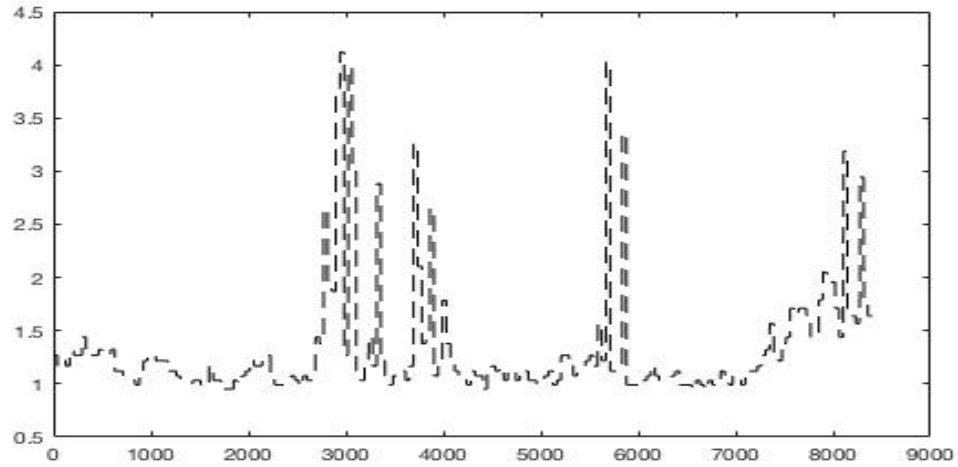
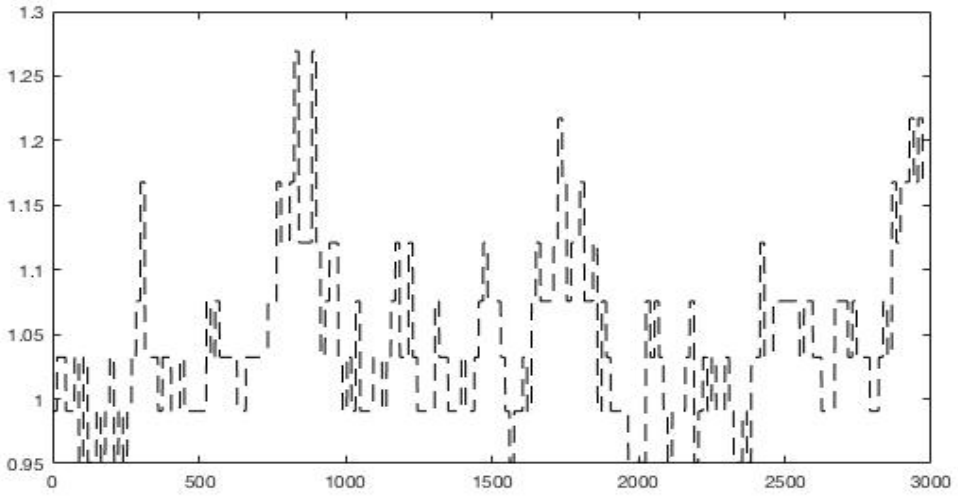


Figure C.12.1– IF estimate for parameters B (Panel 1), α (Panel 2), and σ (Panel 3)





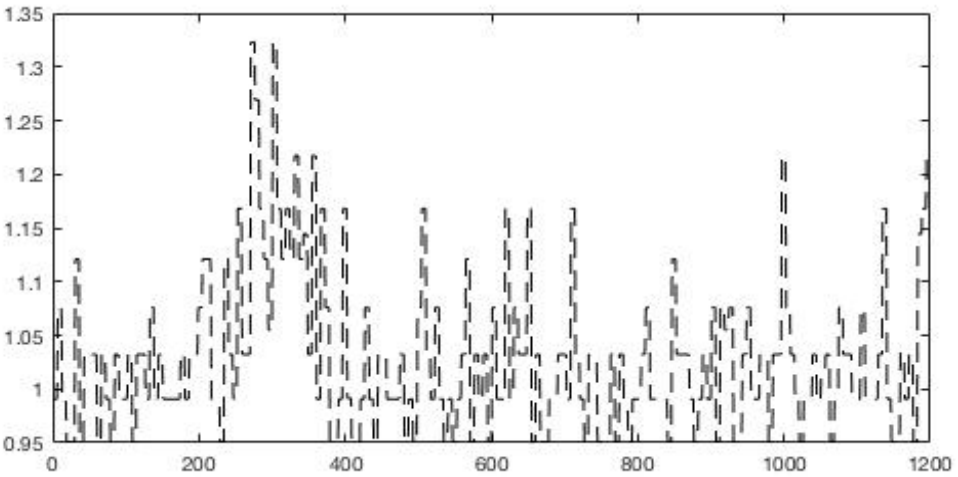


Figure C.12.2 – I-statistic for parameters B (Panel 1), α (Panel 2), and σ (Panel 3)

Appendix D – Historical context

The first step to discover or correct the potential mechanisms whereby monetary policy operates is to review the Federal Reserve's history. This review is necessary to gain insight regarding the learning process of those responsible for monetary policy, Fed's responses to economic and political events, and the general beliefs or conclusions regarding how those responses have determined the path of the American economy. Several authors have invested their time and effort in providing that insight. Fforde (1954), Friedman and Schwartz (1963), Wheelock (1991), Toma (1997), Moore (1990) and Mayer (1999) are some of them. However, according to the level of completeness (from a personal opinion), I have decided to expose mostly those facts narrated in Meltzer (2003, 2009) and Hetzel (2008), but without positioning on whether the facts narrated are correct or not, from an ideological perspective.

1.1 1919-1939

By 1919, governor Benjamin Strong, chairman of the Fed of New York, realised that the spread between the short-term rates and the discount rate would avoid a decline in inflation, as it was profitable for banks to borrow at lower rates and lend. In 1921 began what today is known as the federal funds market. Banks with surplus reserves sold reserves to banks with deficient reserves. However, its relevance was far from what that market is nowadays. By 1922, some members of the Fed noted that reserve banks could increase "momentum" purchasing in the open market and at the same time reducing the discount rate. Strong claimed that buying in the open market was equivalent to a member bank borrowing. Thus, open market operations experiments began in 1922. The discount rate during those years was at discretion of each Reserve Bank and its use was intended to be a penalty rate. Thus, it used to be above short-term rates, at least until 1921-1922, because later, market rates on commercial paper started to be above the discount rate. Apart from that, it was supposed to be the tool to follow the gold standard rules, namely, increasing it in periods of surplus and decreasing it when there was deficit. Also in 1922, Strong noted and commented what would determine monetary policy for the next years. His observation was that when banks were in debt, they used their surplus reserves to reduce borrowing. On the contrary, when they were out of debt, they reduced rates and put their surplus to work. "The reduction in our rate had no influence in the market. It was the competition to lend money that did it" (Meltzer 2003, p. 126). Thus, changes in the discount rate were supposed to be ineffective, but by selling in the open market, the Reserve Banks could

reduce bank reserves and force them to borrow, thereby restoring the effectiveness of the discount policy. In 1964 Burgess reported:

> "First, as fast as the Reserve Banks bought government securities in the market, member banks paid off more of their borrowing; and, as a result, earning asset and earnings of the Reserve Bank remained unchanged…" (Meltzer 2003 p.153).

Given Fed's concern about speculative credit during the 1920s, interest rates were raised to avoid the growth of stock exchange lending, thereby attracting more gold. Consequently, to maintain price stability, the Fed sterilized the gold inflows and the monetary expansions triggered by those gold inflows were reduced or totally cancelled. One characteristic of these years that led Federal Reserve Banks to follow the wrong policy is explained in what was the Riefler-Burgess doctrine. It was believed that banks were reluctant to borrow and they only did it when their reserves were deficient. This triggered that during many years the monetary base and borrowing moved procyclically. That is, the Fed believed that increased aggregate borrowing signalled a restrictive policy even if the monetary base and money stock accelerated. Following this reasoning, it increased the purchases in the open market and decreased the discount rate for those periods, and did just the opposite when borrowing decreased.

At the April 1925 meeting for the Governors Conference, the concern that would continue for the rest of the decade was expressed; credit to securities brokers and dealers. They feared speculative borrowing. Consequently, some Reserve Banks increased the discount rate later, as the open market account was thought to be too small to have a significant effect on reducing bank reserves. The Fed carried out open market purchases in May 1927 because of the recession, and continued in July. However, they were offset by a decline in borrowing and in the reported gold stock. Despite the increase in inflation in 1926, Strong's view of supporting the pound with lower rates dominated. By the end of 1927 Strong had complete authorization to offset gold flows without limit. From 1927 to 1929 the Fed sterilized gold inflows, preventing monetary expansions and triggering, or at least adding to the deflation witnessed for those years. In addition, the members of the Fed were misled by the lower levels of discounts and borrowing, as commented above, believing that policy was already expansive. Apart from that, during this period the discount rate was higher in real terms given the levels of deflation, but they did not distinguish between real and nominal terms. Moreover, the spread between the stock exchange call loans rate and the discount rate became significantly large after the beginning of 1928.

Given the increase in credit to brokers, the Fed thought that its policies were expansive and therefore, rates were not reduced and open market purchases decreased. During 1928, the Federal Reserve offset part of the net gold outflow, but it was insufficient and the monetary base declined. Thus, when New York stopped sterilizing gold losses, discounting increased significantly but the monetary base continued falling. Discounting and bank credit were in the highest levels of the three last years.

"…[O]n December 31, 1928, the Board adopted a resolution that blamed the spread between discount rates and rates for stock exchange loans for the temptation to borrow from the Fed and lend to help buy or carry securities" (Meltzer 2003, p. 237). The Fed spent 1929 trying to reduce bank lending to brokers, as it was thought to be speculative credit, but most of the lending came from corporations and other nonbanks. Hence, the Fed was not successful in reducing call loan rates. Previous to the crash on October 23, call loan rates had already started to decrease and by that date, they were around 6%. However, the Fed refused to reduce the discount rate. At the end of November 1929 the Fed noted that there was being a liquidation of credit against securities, what could suppose a serious threat to business stability, having already in mind that there were indications of a business recession. As the short-term rates had fallen and were expected to fall further, and discounting increased, the Fed approved limited purchases in the open market. Later, industrial production, stock of money, monetary base and borrowing fell. Fed governors thought that the open market purchases had failed to revive the economy. Actually, the Fed had failed to offset the decline in borrowing by purchasing insufficiently. However, the members of the Fed thought that the purchases had already permitted banks to repay borrowing, as borrowing levels had declined. Bank failures along with the increasing demand of the public for currency, contributed to contracting the money supply.

By the end of 1930, Fed's members were deliberating how much to sell in the open market as they considered that policy was loose, since banks were keeping twice the level of excess reserves of the previous year. This offset the inflow of gold at the beginning of the year. Later, as those inflows did not decrease interest rates, the governors decided to purchase in the open market from April to June of 1931. Nonetheless, the rise in currency holding and excess reserve counteracted the effect. In 1932, gold outflow started again, along with a higher demand for currency. The Glass-Steagall Act of April 1932 and threats of additional legislation led the Fed to purchase in the open market. Signs of improvements were soon recognized but as the purchases stopped, the improvements quickly disappeared and gold outflow continued.

Accordingly, it was thought that the program has failed. As already occurred between 1927-1929, since the short-term rates were historically low, the members of the Fed thought that policy was easy and no further purchases were done. However, because of the deflation, real rates were higher. The System kept an inactive role during the next months. From time to time, as in January 1933, the System sold in the open market to keep excess reserves close to $500 million. In the beginning of 1933 short-term rates increased, but the Fed failed by discounting at higher rates than the market, when it should have set the discount rate below the short-term rates.

The last part of the interwar period, from 1933 to 1941 is characterized by the inaction of the Fed, as the Treasury took most of the responsibility for monetary policy. The Fed's open market account and the discount rate hardly changed during this period, and the variations in the monetary base were due to changes in gold stock and the devaluation of the dollar in 1934. Marriner S. Eccles, who became governor of the Board in 1934 believed that the Fed should keep market rates low, in order to facilitate private spending and government finance. Also, he thought that the growing volume of reserves at member banks could mean a threat of future inflation. Thus, reserve requirement ratios became the main instrument of the Fed during these years. In October and November of 1933 the Fed made the last purchases in the open market and it would not purchase again until April 1937.

In 1934, Roosevelt bought gold and silver to raise prices. The base and money stock increased. Also that year, he carried out devaluation up to 60% of the gold. As the president had acquired the gold held by the Federal Reserve banks previously, this devaluation supposed a $2 billion profit, which was used to set up the Exchange Stabilization Fund (ESF). It aimed to retire national banknotes and finance industrial loans. This devaluation supposed an increase in prices and flow of gold into the country. The ESF was also used to buy bonds, in order to keep rates low and finance the deficit. In August 1935, as excess reserves rose and there was fear of future inflation, the Fed decided to increase the reserve requirements ratio. As reserves had increased, discounting decreased and hence, the discount rate could exert little influence, or at least the members of the Fed thought so. This first increase in the reserve requirement ratio had little effect because of the gold inflow. Given the fear of speculative gold inflows and increase in the monetary base, the Treasury sterilized gold inflows between December 1936 and July 1937. Just in this period, deflation appeared again. There were two further increases in the reserves requirement ratio in January and May of 1936. Later, and together with the

sterilization, there was an increase in bond yields, what supposed the restart of the Fed's purchases in the open market to lower short-term rates and indirectly, long-term rates. The increases in the reserves requirement ratio along with contractive fiscal policies supposedly made the money stock to fall, causing a recession by May of 1937. Thus, in September 1937 more open market purchases were undertaken and the Treasury desterilized part of the gold inflows. Consequently, inflation levels increased for the end of the year. Around that time, the Fed proposed to manage open market operations (OMO, henceforth) in response to the level of excess reserves instead of the amount of borrowing. Thus, by 1938 the Fed's purchases in the open market were in small quantities, also because rates were low and it was believed that the monetary policy was easy. However, deflation came back again for the end of the year and the Fed had to reduce reserve requirements ratios, while the Treasury continued desterilizing the gold sterilized for the previous years.

1.2 1950-1957

The main characteristics of monetary policy from 1950 to 1960 were that the Fed still considered low interest rates as loose policy, even though M1 be decreasing; the gain in relevance in the use of OMO in relation to discounting, and that the main target was free reserves, using bank borrowing as an indicator. Money growth did not receive attention despite it was thought to cause inflation in the long run. Still, they did not differentiate between real and nominal rates and continued applying procyclical policies. In 1952 banks borrowed relatively large amounts from the discount window, taking advantage of the spread between the open market rates and the discount rate. In 1954 the federal funds market emerged again, as it had been inactive since the late 1920s.

Regarding discount rate policies the following is found. "At the August 23 1955 FOMC meeting Martin raised two issues: whether the discount rate should be a penalty rate, and whether it should lead or follow market rates… Following the meeting… in mid-September; the discount rate was a penalty rate" (Meltzer 2009a, pp. 127-128).

Later, "The Board reconsidered the role of discounting in its 1957 Annual Report… The Board, at last, recognized that when one bank repaid its borrowing, another might be forced to borrow, so that aggregate reserves did not decline. And it recognized that increased borrowing offset open market sales and that the attitude of member banks toward operation with borrowed resources varies from bank to bank… The Board found no conflict between discounting and

open market operations. Market and discount rates were interdependent. By raising the discount rate above the market rate, the System encouraged banks to adjust by selling securities instead of discounting. Short-term rates rose, reinforcing an open market policy of sales" (Meltzer 2009a, p. 78).

1.3 1958-1970

Already for the period under analysis, there was a recession in 1957-1958. In 1958, the president asked to make price stability an explicit goal of economic policy. The Great Inflation was underway during the 1960s, sustained by rapid money growth to finance the government budget and government spending for the Vietnam War. One of the Fed's problems during this period was that it acted to reduce inflation only until unemployment rose. Given the unpopularity of inflation since 1965, emphasis shifted between those two goals.

Free reserves were increasing in 1960 and the Fed interpreted it as easy policy. As the economy slowed, discount rates decreased and free reserves and federal funds rate rose. During 1961-1962, the free reserves target was questioned and for the first time there was a target for the T-bill rate. On January 1962, an increase in deposit ceiling rates was approved. When the Fed began to control interest rates during those years, the problem was that they contained less information about the market position. "Instead of the market being a window through which we can observe indications of private actions that might call for policy changes, we have made it—in part at least—a mirror of our own intentions with respect to rates" (Meltzer 2009a, p.429). In 1963 the free reserve target was abandoned and more attention was dedicated to the federal funds rate and less to the T-bill rate. In early 1965, the first of several errors to control inflation was made, when the president's Economic Report announced the need for further expansion, even though signs of strength had already appeared. The same year, the federal funds rate became again higher than the discount rate. Since the Fed targeted a short-term rate, to prevent a change on it when the deficit increased, the Fed had to allow the monetary base to increase. Fiscal policy contributed to inflation with the president Johnson's large deficits in 1967-1968. Before Martin left the Fed in January 1970, the Fed had adopted growth money as a policy indicator and instructed the manager to change money market conditions if money growth deviated from a 2% annual rate. When Burns became chairman of the Fed, the manager in charge of OMO lost much of his autonomy and the "tone and feel policy" ended forever. Money growth became the target and the FOMC would take decisions based on a total reserves target. Money and bank credit growth were used as target rather than as projection, meaning, the

manager would change the federal funds rate when he missed the target. As the procedure began raising federal funds rate, the System ended up supplying more reserves, in part to prevent the failure of the Treasury financing. Thus, the FOMC soon gave up on monetary control. Higher rates supposed higher unemployment, and Burns disliked the result. By August 2, wage and price controls were imposed. Also the gold window was closed, and the currency was allowed to float.

"In short, the simple Keynesian model as applied in the late 1960s had three major flaws. It did not generally distinguish between nominal and real interest rate changes. It presumed that the government could permanently reduce the unemployment rate by permitting the inflation rate to rise. And it did not distinguish between one-time price level changes and maintained rates of price change. Each of these errors continued throughout the 1970s" (Meltzer 2009a, p.490).

1.4 1971-1980

This decade started with a freeze in prices and later, in interest rates, rates charged on mortgages, and consumer credit. Burns believed that in order to achieve full recovery without inflation, it was necessary to increase profits and lower wages growth, as it was understood that cost-push by unions was causing inflation. Another three phases of price controls were extended until 1973. Although in the beginning they decreased inflation, once finished, inflation increased even more. In the end, the public lost credibility on these controls.

During these years, it was usual to target growth in monetary and credit aggregates, setting at the same time lower and upper bounds on the federal funds rate. Before the elections in 1972, it is said that Burns was pressured by the government to increase growth and decrease unemployment. Once the elections passed and the administration loosed price and wage control, there was an inflationary outbreak due to those expansionary policies. In 1973, member bank borrowing rose to levels not reached since 1921 and the discount rate rose only in August 1973. Again, due to positive the spread between the discount rate and federal funds rate from 1972 to 1975. The Fed was also targeting the growth of reserves against private deposits during this period. The procedure contributed to increasing inflation as the staff estimated the growth of reserves and the level of federal funds rate consistent with the desired growth of money. Several times, they did not match and the band on federal funds rate had to be changed. In the end, the manager maintained the federal funds rate and exceeded the reserve target. As inflation increased, the federal funds rate and the discount rate reached levels never seen before. However, such was the spread between both rates that member bank borrowing increased

significantly, contributing to the growth of the monetary base. It seems that along with the excessive monetary and fiscal expansion of 1972, the removal of price controls in 1973, the devaluation of the dollar after 1971, poor harvest abroad and the increases in oil prices, added to the rise in inflation. Beginning in 1975, borrowing declined and the federal funds rate came down rapidly. The FOMC continued using the federal funds rate as it principal target during this decade. "This period is unique in that the Fed controlled the funds rate so closely that market participants could identify most changes in the funds rate target on the day they were first implemented by the Fed, and these changes were reported by the market participants in the financial press the following day" (Meltzer 2009b, p. 892).

By October 1978, inflation had become a political issue as public opinion saw it as a major problem. In December 1978, the oil-producing countries decided to raise prices again. Inside the FOMC, more arguments appeared regarding how to control inflation and how this could reduce employment at the same time. Other concern was that the lack of credibility was damaging the effect of raising the federal funds rate, as the public expected that the Fed would not continue its restrictive policies and prices would increase again. Mark Willes claimed:

> "We can in fact have less inflation without more unemployment in 1980 if we have policies in 1979 that are…firmly held to so that people really believe we are going to follow through on them (FOMC Minutes, February 6, 1979, 19)" (Meltzer 2009b, p.940).

1.5 1980-1990

In August 1979, Volcker became chairman of the Fed. At his confirmation he already distinguished between real and nominal interest rates and expressed inflation as his main concern. He, following Milton Friedman, accepted that inflation could not be reduced unless money growth declined relative to growth of real output. The FOMC used a federal funds rate target and announced objectives for growth of M1 and M2 to reduce money growth. For that task, Volcker targeted nonborrowed reserves. However, they also paid attention to total reserves to move the target for nonborrowed reserves. "Monetarists criticized the procedures at the time, arguing that they made both interest rates and money growth more volatile. Growth of the money stock depends on reserve growth (or the monetary base). By holding to a fixed value (or growth) of nonborrowed reserves, banks had to borrow any deficiency to meet required reserves on deposits outstanding two weeks earlier, thereby increasing total reserves. …Further, keeping the discount rate as a penalty rate slightly above the average federal funds rate, would reduce

borrowing. Most often, the Fed subsidized borrowing in 1979-82 by allowing a wide spread, 4 or 5%, between the average federal funds rate and the discount rate. This encouraged borrowing and weakened control of money" (Meltzer 2009b, p. 1028).

The attitude change on the FOMC was apparent once despite the recession of 1980, it favoured slower money growth. However, although by March the discount rate was raised, the action was insufficient and late. Heavy borrowing continued because of the subsidy of around 4 percentage points. Twelve years after Friedman's insistence on the effect of expectations, the Fed accepted that it could not permanently reduce unemployment by increasing inflation. Now, it was claimed that low inflation increased employment. The recession of 1980 and the posterior decrease in the discount rate in July avoided that the credibility on the Fed augmented. Policy tightened sharply in the spring of 1981, when the FOMC continued increasing the federal funds rate despite the recession and the unemployment rate near 8% in the fall. Market participants recognized that the Fed was fighting inflation. Thus, credibility increased. This was a turning point. By October, CPI inflation decreased quickly. The speed of the fall surprised the Fed. In part, it was ameliorated by the dollar appreciation undergone from 1980 to 1985. In 1982, the FOMC finished targeting nonborrowed reserves, and Volcker clearly began to shift to an interest rate target. He did not trust on M1 anymore:

> "On these money growth targets, in substance, I don't care. I think either of these two sets of numbers [5.5 and 6.5%] will make no difference, virtually, in what we actually do… [W]e are within the limits of the growth targets anyway". (Meltzer 2009b, p. 1114).

> "I, frankly, cannot live in these circumstances, given what is going on in the money markets, with violent moves in short-term rates in either direction. It would just be so disturbing in terms of expectations, market psychology, and fragility that it's just the wrong policy, period, during this particular period." (Meltzer 2009b, p.1115)

Shortly later, Volcker targeted borrowing to around $500-$600 million to prevent a raise in the interest rate. Thus, the System returned to the target used in 1920s and the basis for the free reserves target in the 1950s and 1960s. Policy became discretionary based on Volcker's judgment. Despite inflation had decreased significantly by the end of 1982, it was still high and again, created skepticism about the Fed's purpose of reducing it. In 1983-1984, long-term rates increased again. Consequently, inflationary expectations proxied by bond rates replaced money

as intermediate target. Later, Greenspan concerns and focus on shaping the expectational environment would turn Volcker's experiment into a new monetary standard. A renewed rise in bond rates in the spring of 1984 tested Fed's compromise to fight inflationary expectations. Again, in 1984, Morris pointed out that the differential between the federal funds rate and the discount rate was of 2 percentage points and borrowing had reached $1 billion. He proposed to increase the discount rate 1 percentage point but Volcker replied that it would mean "an explosion in Washington". Thus, during those years, many increases in the discount rate were not undertaken because of the pressure from the administration. When Greenspan replaced Volcker in August 1987, he set a narrow band around a federal funds rate target, which was adjustable depending on inflation and stable growth. In 1987, there was another inflation scare due to the depreciation of the dollar.

1.6 1990-2007

After the recession in 1990, the FOMC followed a "soft recovery" strategy and Greenspan focused on reducing expected inflation by reducing bond rates rather than just focusing on them during inflation scares. However, inflation concerns appeared in mid-1990 when Iraq invaded Kuwait and oil prices raised. Another inflation scare was faced in the beginning of 1993, but the Fed kept raising the federal funds rate during the next months until February 1995. "By the end of the decade, financial market had stopped associating high real growth with a resurgence of inflation. The Fed had defeated the "bond market vigilantes"" (Hetzel 2008, p. 205). By 1998, falling unemployment rate and low inflation created expectations about an increase in the federal funds rate. Nonetheless, low world growth perspectives led to lower the federal funds rate. Thus, the FOMC exacerbated an unsustainable rise in equity prices. From mid-1997 through mid-1999, the FOMC changed its procedures and raised rates when resource utilization rates were high. Greenspan believed that monetary policy should counter irrational expectations. He did not increase the federal funds rate again until February 2000 because he did not consider inflation as a threat. He believed that productivity growth was restraining inflation. As inflation and unemployment fell together after 1995, Greenspan explained:

> "The lack of pricing leverage has once again concentrated the minds of business people on the need to increase productivity… [E]conomic experience appears to be running full circle, back to the early 1960s: a period of low-inflation and strong productivity growth …[L]ower inflation historically has been associated…with faster growth of productivity… Lower inflation and inflation expectations reduce uncertainty in

economic planning and diminish risk premiums for capital investment" (Hetzel 2008, p.231).

After the Asian financial crisis, the FOMC began to raise the federal funds rate. The equity market began its rise in 1995 until its peak in early 2000. After that peak, the NASDAQ began a prolonged fall after September 2000 and investors lost a significant amount of wealth. Consumption growth rates fell and the economy weakened. In January 2001, the Fed decreased rates, slowly and late. Thus, policy was contractionary by then. In 2001, policy followed the lean-against-the-wind pattern, whereby the FOMC raised (lowered) the funds rate in a persistent, measured way if the economy grew above (below) trend. The characterization for the last years of the Greenspan era is that the FOMC pursued its basic expected inflation/growth gap procedures but raised its implicit inflation target from price stability to low inflation.